phoenix|x-ray
Systems + Services

nanome|x 180 NF

Version 2.0

Operating Manual

Phoenix|X-ray Systems+Services reserves the right to introduce technical modifications in line with technical progress.

Contents, designs and technical specifications are subject to change without notice.

Illustrations not binding.

General Information

This user manual provides important information on the workings, operation, maintenance and operational safety of your X-ray unit. Please read carefully!

ATTENTION!

Make sure to carefully read this manual prior to installation and operation of this X-ray equipment.

This manual provides the user with the necessary information to ensure safe operation of this X-ray unit.

Keep this manual handy and in a safe place for future reference.

In case of this manual being lost or damaged, please contact our Sales or Customer Service Department for a replacement copy.

In case the X-ray unit is moved to another location, make sure not to leave the manual behind.

phoenix|x-ray reserves the right to modify this manual and the product described herein without prior notice.

CAUTION!

This equipment produces X-rays harmful to the human body. To avoid health problems arising from exposure to X-rays, exercise the greatest possible caution in using this X-ray unit. In complying with the German X-ray Ordinance Annex III Paragraph 3, this X-ray unit is equipped with a high-security radiation protection cabinet as well as several other safety devices.

The X-ray unit may be operated by, or under supervision of, authorized, trained individuals only.

General Information

System type

Model name: nanome|x 180 NF

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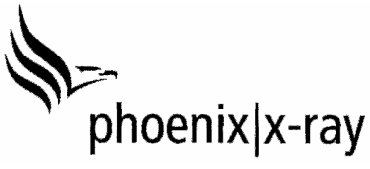


TABLE OF CONTENTS

1 Important Safety Information 7

1.1 Responsibilities and Liability 7

1.1.1 Potential risks in using this X-ray unit 7

1.1.2 Warranty and Liability 7

1.2 Warning Signs and Symbols 8

1.3 Safety Precautions 9

2 Product Description 12

2.1 System features 12

2.2 Technical specifications 12

3 Transport 14

4 Installation and Start-up 15

4.1 Layout Chart 15

4.2 Set-up and set-up site 16

4.3 Electrical installation 16

5 Components of the X-ray unit 17

5.1 Main switch and warning light 17

5.2 Key-Switch 17

5.3 Emergency Stop- Switch 17

5.4 Safety Interlock Circuit 17

5.5 Laser position holder (optional) 18

5.6 Laser anti-collision protection (optional) 18

5.7 Manipulator control panel 19

5.8 X-ray tube 21

5.9 X-ray control 22

6 Fundamental operating instructions 23

6.1 Turning on the X-ray unit 23

6.2 Initializing the X-ray tube 23

6.3 How to generate X-rays 23

6.4 Discontinue X-ray generation/Turning off X-rays 23

6.5 Turning off the X-ray unit 24

6.6 Disconnecting the X-ray unit 24

7 Controlling the X-ray tube using the "xs|control" software 25

7.1 Software components 25

7.1.1 Main window „xs|control" 26

7.1.2 Window- „Additional Functions" 28

7.1.3 Window „Timer" 29

7.1.4 Window: Dose rate control (optional) 30

7.1.5 Optional feature: Power Mode 30

7.2 Operating instructions 31

7.2.1 Priority of „X-Ray OFF" 31

7.2.2 Setting high voltage and tube current 31

7.2.3 System initialization 31

7.2.4 Tube warm-up 31

7.2.5 Auto-Centering 31

7.2.6 Target Check 31

7.2.7 Venting the tube for maintenance purposes 32

7.3 Fault Indicators and Error List 32

7.4 Installation Instructions 32

8 Causes of failure and trouble-shooting 33

9 Lubricants and Cleaning Agents 34

10 Special Substances 35

11 Maintenance 36

11.1 Safety Precautions 36

11.2 Maintenance Schedule 37

12 Servicing the X-ray tube 38

12.1 Replacing the plug-in cathode 38

12.2 Setting a new target position 40

12.3 Replacing the Transmission Target 41

12.4 Servicing the high-voltage cable 42

13 Servicing the Vacuum System (Option) 43

13.1 Replacing the lubricant reservoir 43

14 Servicing the Manipulator 45

14.1 Lubricants 45

14.2 Manipulator 46

15 Servicing the radiation protection cabinet 48

15.1 Lubricants and Cleaning Agents 48

15.2 Cabinet 48

15.3 Lead glass window 48

15.4 Loading door 48

16 Spare parts 49

17 Appendix 50

17.1 Connection to Supply Line 50

17.2 Wire diagrams 51

17.3 Clamp boards 70

1 Important Safety Information

This section provides the user with the information necessary to operate and handle this X-ray machine safely. Please take the time to carefully read this manual prior to installation and operation of the X-ray unit and observe the safety instructions and warnings detailed in this manual at all times.

This X-ray unit generates X-radiation and is to be operated by, or under the supervision of, authorized, trained individuals only. This X-ray unit must be used in compliance with the applicable health and safety laws and regulations to prevent injuries and health damage caused by ionizing radiation. For further information, please refer to and observe the applicable Radiation Safety Laws and Ordinances.

1.1 Responsibilities and Liability

Note: Always observe the safety instructions and warnings detailed in this manual!

To ensure safe and trouble-free operation of the X-ray unit, it is imperative that the operator, and anyone using the equipment, understands and follows the safety precautions and devices in this manual as well as all applicable safety regulations and requirements. Anyone using this X-ray unit must comply with the instructions, especially the ones related to radiation safety, detailed in this manual. Moreover, all applicable local laws and regulations regarding Radiation Safety and accident prevention in general are to be observed.

1.1.1 Potential risks in using this X-ray unit

This X-ray unit is a state-of-the-art device and was designed and manufactured according to the applicable safety regulations and requirements for high-power X-ray machines. The possibility, nevertheless, that the operation of the X-ray unit may result in injuries or property damage of any kind cannot completely be excluded.

Only use the X-ray unit:

- As intended by the manufacturer.
- If it is completely safe to use.
- When tube initialization and manipulator reference point travel were completed successfully and without faults.

Any defect endangering safety must be eliminated immediately.

1.1.2 Warranty and Liability

Phoenix|x-ray's terms and conditions apply. A copy is available upon request, but will be provided at signing of contract at the latest. phoenix|x-ray Systems + Services is responsible for neither injuries nor property damage caused by one or several of the following:

- The X-ray unit was not used as intended by the manufacturer,
- Improper assembly, installation, putting into operation, operation or maintenance of the X-ray unit,
- Operation of the X-ray unit despite defective, improperly installed, or non-functioning safety and protection devices and features or incorrectly working safety circuits or interlocks,
- Failure to observe the instructions detailed in this manual regarding transport, storage, installation, start-up, operation, maintenance or upgrades of the X-ray unit,
- Unauthorized technical modifications,
- Insufficient maintenance of consumable parts,
- Improperly performed repairs,
- Disasters, vandalism, war, foreign object damage and damage due to force majeure.

1.2 Warning Signs and Symbols

The warning symbols used in this manual or on the X-ray unit are classified as detailed below. Carefully read the following and observe at all times:

DANGER	Indicates an imminently hazardous situation which, if not avoided, **will result in death** or serious injury.
WARNING	Indicates a potentially hazardous situation which, if mishandled, could result in death or serious personal injury.
CAUTION	Indicates a potentially hazardous situation which, if mishandled, could result in moderate or minor personal injury, and/or property damage.
	Indicates what not to do. Never attempt since doing so may result in personal injury and/or system damage.

Other warning signs used in this manual and on this X-ray unit:

	Caution: X-radiation
	Caution: Toxic material
	Caution: Laser beam
	Caution: High voltage! Danger to life!
	Ground cable- Do not use as protection earth!
	Caution: Moving parts can crush and cut!

1.3 Safety Precautions

	DANGER
	X-rays are a potential health hazard. This X-ray unit contains an X-ray tube generating X-rays harmful to the human body. Always be extremely careful when operating the X-ray unit to avoid direct exposure to X-rays. The X-ray source is shielded by a radiation protection cabinet, which is equipped with 2, mutually independent, safety interlocks to prevent accidental exposure. This X-ray unit fully complies with the rules and regulations of the German X-ray Ordinance Annex III Paragraph 3. At 5cm (2") from the exterior surface of radiation protection cabinet, the local dose rate does not exceed 1µSv/h (0.1 mR/h).
	Beryllium is a potential health hazard. The X-ray tube's window is made of beryllium. In case of window damage or breakage, switch the X-ray unit off immediately and contact our customer service department for proper disposal. Beryllium particles, especially powder or dust, which may result from the breakage, are harmful to the human body. Never inhale beryllium dust or powder, since this may cause respiratory problems.
	Class 2 Laser Source (Optional). If this X-ray unit is equipped with one (or more) laser sources; avoid looking directly into the laser beam, not even with optical instruments. Wave length 635-670 nm, red Power output max. 3 mW, pulse-length 3,5 µs
 	Do not disassemble or modify the X-ray unit Never modify or disassemble any component of this X-ray unit. Disassembly and/or modification may adversely affect the internal circuitry which may result in X-ray unit failure or failure to generate X-rays. Generator and X-ray tube generate extremely high voltages as high as 450 kV depending on the type of X-ray unit. Never remove or attempt to remove any panels or covers, since this may result in electrical shock or X-ray unit breakdown.
	Moving parts can crush and cut! The loading door weighs up to 50kg/110lb and can nevertheless easily be moved. Use caution when handling the loading door and only move it slowly. The loading door must only be moved by properly using the door handle.

	WARNING
	High precision instrument – Handle with care. This X-ray unit is a high precision instrument. Always handle with extreme care and avoid shocks or vibrations during transport, installation, or operation. Failure to observe this warning may result in X-ray unit failure or breakdown.
	Do not install where high amounts of moisture, humidity, steam, dust or corrosive gases are present. Failure to observe this warning may result in electrical shock or fire.
	Do not operate where chlorine is present, since chlorine corrodes the beryllium tube window.
	Do not use a different supply voltage than the one specified by the manufacturer. Failure to observe this warning may result in electrical shock, fire and X-ray unit damage.
	Do not use a different power supply cord than the one supplied by the manufacturer. Failure to observe this warning may result in fire or electrical shock.
	The X-ray unit must be properly grounded at all times. The X-ray unit must be grounded via the power supply cord at all times to prevent electrical shock.
	Never allow any extraneous objects or fluids into the X-ray unit or its components. In this event, do not operate the X-ray unit under any means and immediately contact our customer service department. Failure to observe this warning may result in electrical shock or fire.
	Never operate the X-ray unit in extreme or abnormal conditions. In case of smoke, unusual odors or noises emerging from the X-ray unit, do not continue to operate the X-ray unit, since this would be extremely dangerous. Switch off the X-ray unit immediately and contact our Customer Service Department.

	CAUTION
	Do not apply excessive mechanical force or stress to the power cord and connection cables. Do not step on the power cord and connection cables. Do not bend cables sharply or kink. Avoid sharp edges. Improper handling of power or connection cables may result in electrical shock or fire. In case of cable damage, discontinue any operation of the X-ray unit and contact our customer service department.
	Do not block air vents. Make sure that no air vents are blocked by walls or other objects since this may cause the X-ray unit to overheat resulting in system failure or fire.
	Room temperature must never exceed 30°C. Temperatures over 30°C may cause the X-ray unit to overheat.
	Do not scratch, damage or break the tube exit window, since it may contain beryllium depending on your type of X-ray unit. In case this window is damaged or broken, do not operate the X-ray unit and have the window replaced in compliance with the applicable safety precautions and regulations. Beryllium particles and dust are a health hazard. Inhalation of airborne beryllium may cause severe respiratory problems.
	Always stop the X-ray generation before opening the door to the radiation protection cabinet by selecting “X-ray OFF” from the xs|control interface. Always shut down the computer before turning off the system. Failure to do so may cause damage to the X-ray unit.
	Only operate the X-Ray unit when Tube initialization and manipulator reference point travel (starting with turning on the system) were completed successfully and without faults

2 Product Description

2.1 System features

- Easy and quick adjustment of tube voltage and tube current
- Automated tube warm-up.
- High operational safety due to several interlock circuits
- Pre-settable X-ray parameters (high voltage and tube current)
- Easy-to-use manipulation system.
- Auto-Positioning Control APC
- image processing software: quality|assurance
- High quality 4 “ single field Image Intensifier (optional double field)
- Special X-ray CCD-Camera
- Optional: 6” mage Intensifier
- Optional: high-contrast|set
- Optional: Rotary / Tilt axis
- Optional: ovhm|module 2 with 70° pivot angle
- Optional: ovhm|module 4 with 70° pivot angle
- Optional: rotation|table
- Optional software: wire sweep, BGA, voiding calculation
- Optional: Laser crosshair for even more user-friendly manipulation
- Optional: Anti-collision protection to prevent sample damage

2.2 Technical specifications

General Data

Dimension WxHxD (without control panel)	2020x1920x1860 mm
Weight ca.	2400 kg

Power input

Voltage	1~ 230 VAC/N/PE, 50 Hz optional 1~ 110 VAC/N/PE, 60 Hz
Maximum power	2000 VA
Fuse in power supply	1 x 10 A
Max. current in regular operating mode	8.7 A
Switching capacity of the safety switch in the power supply connector (according to IEC 947-2)	10 kA

Environmental operating conditions

Temperature	10°C - 30°C
Humidity	25% - 85% rH, not condensing

X-ray parameter

High voltage	10 kV – 180 kV
Tube current	5 µA – 880 µA (15W Isowatt)
Tube window	Beryllium (400 µm deep)
Useful beam angle	approx. 180°
Feature recognition	0.4 µm
Leakage radiation	< 1 µSv/h

3 Transport

DANGER

To prevent injury and system damage, please observe the following:

- All lifting and handling devices and lifting tackles must comply with the applicable safety and accident prevention regulations!
- Select a mode of transport suitable for the weight of the X-ray unit (see Layout Chart)!
- Only authorized and trained individuals may perform the transport!

The X-ray unit is shipped completely packed and may be handled using a forklift or lifting truck. Place forks under X-ray unit and lift carefully. Alternatively, a crane can be used.

Pull belts through underneath the X-ray unit and sling load onto crane hook. Make sure to select the right sling using the manufacturer's table showing the safe capacities of slings. Be careful that the belts stay in place to prevent damage to unit or parts such as control panel, switches, and warning lights.

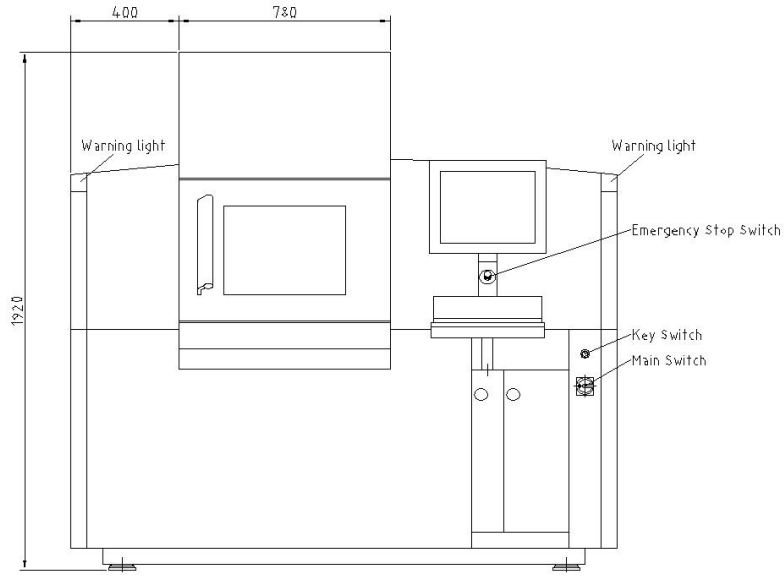
4 Installation and Start-up

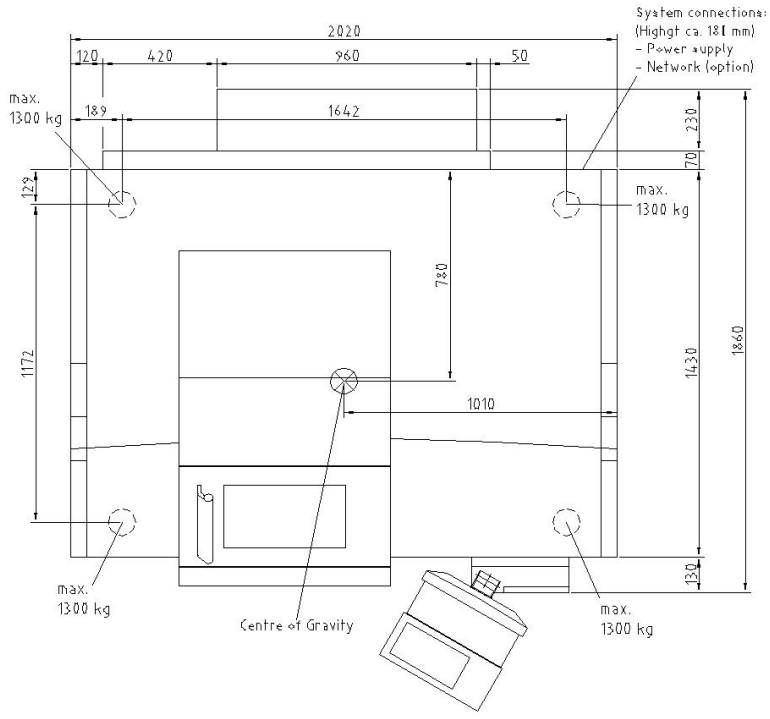
DANGER

In order to prevent system damage and injury:

Only authorized, trained individuals may set up, install and operate the X-ray unit. Prior to set-up and installation, make sure that the weight of the X-ray unit does not exceed the floor's load bearing capacity.

4.1 Layout Chart





4.2 Set-up and set-up site

In order to ensure trouble-free operation of your X-ray unit:

Select site of installation so that the X-ray unit is located horizontally and on level ground. Put unit down on its four feet and align horizontally.

In case it is necessary to additionally secure the X-ray unit, as may be the case in earthquake risk areas, remove all four feet and use the 4 threads (M16) to fasten the X-ray unit onto a vibration isolation plate or foundation.

It is crucial that all connections are firmly attached. Double-check for firm connection.

When installing tubes and cables, make sure to avoid creating tripping hazards.

See layout chart for the minimum area required. For operating and maintenance purposes, please make sure that the X-ray unit can be accessed from the front and right.

4.3 Electrical installation

DANGER!

The electrical installation of the X-ray unit may be performed by authorized and qualified electrical technicians only!

All electrical interconnections can be accessed through the openings on the lower back side of the radiation protection cabinet. It is crucial that the electrical installation is performed in accordance with the grid connection diagram (see appendix).

Optional: Depending on your country's power supply and the type of voltage, it might be necessary to use an intermediate transformer, which can be ordered along with the X-ray unit.

5 Components of the X-ray unit

5.1 Main switch and warning light

The main switch is located on the right side of the X-ray unit and can be set to either “ON” (I) or “OFF” (O). In ON-position, the X-ray unit is connected to the power grid; in “OFF”-position, the X-ray unit is completely cut off from the grid. The position of the switch does not affect the equipment grounding function.

This X-ray unit is supplied with a red warning light, which, for better visibility, is located on top of the radiation protection cabinet. It will be flashing red during X-ray generation.

CAUTION

The warning light is flashing red during X-ray generation.

5.2 Key-Switch

The key switch is located on the X-ray unit's front on the right hand side. Turn the switch into „ON“ position to turn on the X-ray unit and X-ray control. In “Stand by” mode, the X-ray unit is on but the interlock circuit is open so that X-ray generation is not possible!
The key can only be removed when the switch is on „OFF“ or „Stand By“.

5.3 Emergency Stop- Switch

The emergency stop switch is located on the main control panel. Pressing the emergency stop switch immediately disables the entire X-ray unit, leaving it without electricity and stopping the manipulator and the production of X-rays. In order to release the emergency stop switch, turn it counter-clockwise and pull it upwards.

After using the emergency stop switch, an automatic restart is not possible. Set the key switch to “OFF” and then back to “ON” and restart the X-ray unit.

5.4 Safety Interlock Circuit

The door of the radiation protection cabinet is supplied with two safety interlock switches.

These switches are positive opening door switches controlling the safety interlock circuits. Opening the door interrupts the power supply to the high voltage generators thus stopping the production of X-rays. At the same time drive motors and lasers, if any, are being stopped immediately.

5.5 Laser position holder (optional)

This X-ray unit can be supplied with 2 lasers, which serve to indicate the position of the central beam between X-ray tube and detector. Opening the loading door automatically deactivates both lasers. Additional safety precautions are not necessary.

CAUTION

Laser radiation!!
Never look into the beam of the laser, not even with optical instruments.
Laser Class 2, max. 1mW

5.6 Laser anti-collision protection (optional)

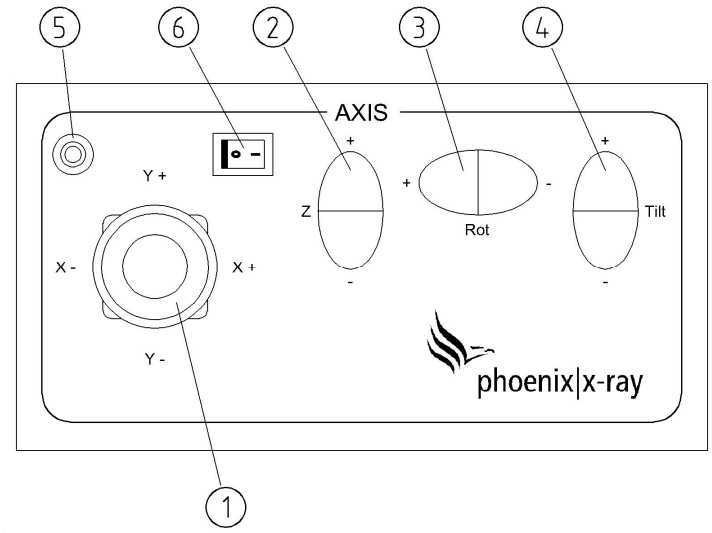
This X-ray unit can be supplied with a laser module which prevents the sample from colliding with the X-ray source. This feature can also be deactivated.

Opening the loading door automatically deactivates the laser. Additional safety precautions are not necessary.

CAUTION

Laser radiation!!
Never look into the beam of the laser, not even with optical instruments.
Laser Class 2, max. 3mW, pulse length 3.5µs

5.7 Manipulator control panel



ATTENTION! It is possible to deactivate the anti-collision protection feature to obtain best possible results. But, when doing so, always use extreme care in handling the manipulator to prevent damage to sample and tube.

(1) Joystick for X-/Y- axis

Controls the manipulator movements in X or Y- direction within the horizontal plane.

(2) Joystick for Z-axis

Controls sample magnification.

Moving the object under evaluation towards the tube („Z+“) increases magnification. Moving it away from the tube („Z-“) decreases magnification

(3) Joystick Rotary Axis („Rot“ ; optional)

What this joystick does depends on which of the following features your X-ray unit is supplied with:

- Option 1: Rotary table:
  The sample rotates on the horizontal sample table.
- Option 2: Rotary/tilt axis:
  Controls the second rotary axis. Allows rotating smaller objects as desired clock or counter clockwise.
- Option 3: Rotary axis:
  Rotates the sample perpendicularly to the beam axis.

(4) Joystick Tilt Axis („Tilt“; optional)

What this joystick does depends on which of the following features your X-ray unit is supplied with:

- Option 1: Rotary/tilt axis
  Controls the second tilt axis.
- Option 2: ovhm|module
  Changes the detector angle.
  Note: In case your X-ray unit is supplied with both the rotary/tilt axis and the ovhm|module, this joystick serves for tilting the axis only. The detector can be controlled using the software interface.

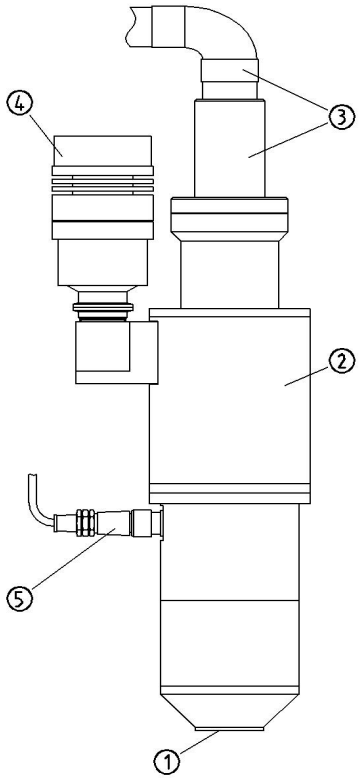
(5) Socket for ESD-Sample Protection bracelets

This socket serves as an earthing contact for ESD- bracelets, which are recommended for use around objects and components sensitive to electrostatic discharge.

(6) Selector switch: Detector (with OVHM IV, optional)

Use this switch to select the detector you would like to use. Select „O“ for the image intensifier and „I“ for the digital detector.

5.8 X-ray tube



(1) Tube window

This is the window, the X-rays are emitted through. The target's center is 0.4 mm deep. This provides for a minimal focus-object distance of 0.4 mm for highest geometrical magnifications.

WARNING

The X-ray tube window consists of beryllium. Never touch the beryllium window with bare hands. In case the X-ray tube must be disposed off, make sure to follow the applicable laws and regulations or contact our Customer Service Department.

(2) High- voltage part

(3) High- voltage cable with flange

(4) High- vacuum unit

(5) Tube plug

5.9 X-ray control

The X-ray control allows the user to control and monitor all operational components and processes, such as tube warm-up, X-ray production or setting of operating parameters. For information on how to use the X-ray control, please consult section 6 and 7 of this manual.

6 Fundamental operating instructions

6.1 Turning on the X-ray unit

To turn on the X-ray unit, proceed as follows:

- Set the main switch to „ON“(I).
- Set the key switch to „ON“.

The X-ray unit is now in operating mode.

Provided the door is shut, the initialization will now start automatically.

6.2 Initializing the X-ray tube

In order to ensure trouble-free operation and maximum lifetime of the tube, it is crucial that an initialization procedure is performed every time the X-ray unit is turned on.

Provided the door is shut when the button is pressed, initialization will start automatically. Otherwise, you will have to manually start the initialization procedure. Make sure that the door is now firmly shut and select the appropriate buttons from the xs|control interface to perform the initialization procedure. For more information, please refer to section 7.1.1: *xs|control.*

While the tube is being warmed up, the warning light on top of the X-ray unit is blinking red. A status indicator shows the progress of the automated initialization process, which is specifically matched to the tube.

As soon as initialization is complete, the warning light stops blinking. X-ray production may now be started by selecting “ON“ from the X-ray control section.

WARNING

During initialization, the X-ray source is being operated under extremely high voltages. This may result in the production of small amounts of electric current and, as a result, small amounts of X-radiation.

6.3 How to generate X-rays

To initiate the production of X-radiation, select the button „X-ray ON“ in the main window (see Section 7.1.1). You may pre-select the values for high voltage and tube current or adjust them while X-rays are being produced. We recommend combining both methods in order to achieve the desired X-ray image.

6.4 Discontinue X-ray generation/Turning off X-rays

Select „X-ray OFF“ from the “X-ray control” section from the main window. The warning light on top of the X-ray unit goes out.

CAUTION

Make sure to turn off the X-radiation (press „X-ray OFF“), before opening the door to the radiation protection cabinet!

6.5 Turning off the X-ray unit

To turn off the X-ray unit, proceed as follows:

- Select „X-ray OFF“ from the main window.
- Exit all programs and Windows and shut down the computer.
- Set the key-switch to „OFF“.
  The X-ray unit is now in off- mode.
  Remove the key and store it in a safe place.
- Set the main switch to „OFF“(0).
  The X-ray unit is now cut off from the main power supply (except for the power supply filter).

CAUTION

The key-switch is a very important element in ensuring the safe operation of the X-ray unit. Only authorized individuals may have access to the key!

6.6 Disconnecting the X-ray unit

To protect the X-ray unit against unauthorized access or unintentional activation (for instance during maintenance) proceed as follows:

- Inform everybody concerned of the maintenance work.
- Switch off and shut down the X-ray unit as described above in section 6.5.
- After setting the main switch to „OFF“(0) lock it with a padlock.
- Remove the key and store it in a safe place.
- Make sure nobody remains on the X-ray unit.
- Make sure the X-ray unit is completely turned off by trying to restart it.
- Put up a sign indicating until when the X-ray unit will be out of service.

Once maintenance is complete and the X-ray unit in perfect working order:

- Take down the sign.
- Make sure nobody remains on the X-ray unit.
- Take off the padlock.
- Set the main switch to „ON“(I).
  The X-ray unit is now reconnected to the main power supply.
- Now, set the key-switch to „ON“.
  The X-ray unit is now activated. Provided the door is shut, the initialization process will now automatically start.
- Inform everybody concerned that the X-ray unit is back in service.

7 Controlling the X-ray tube using the “xs|control” software

WARNING

The use of this software is likely to result in the emission of X-radiation. It is therefore crucial to restrict access to this software to trained individuals with expertise in radiation protection.

“xs|control” by phoenix|x-ray is a software designed for controlling phoenix|x-ray- tubes through a PC.

The software, which is started by double clicking a desktop icon with the same name, communicates via a serial interface with the X-ray control.

The software is perfectly matched to the structure of the multiprocessor X-ray control.

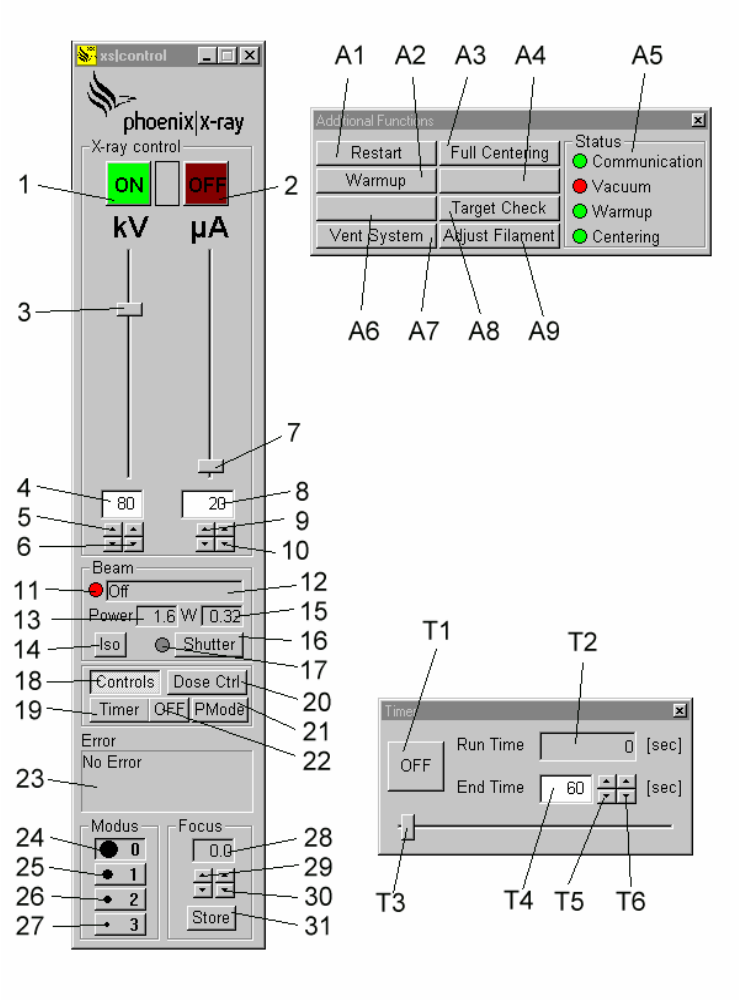
Additional features such as control displays and a timer control function allow easy system control.

7.1 Software components

The window layout enables easy and intuitive operation.

An activated button indicates that a software feature is available; buttons, however, that are not available are faded out. When the X-ray unit is ready to generate X-rays, the button “X-ray ON” appears in light green. While the X-ray unit is generating X-rays, the warning light symbol between “X-ray ON” and “X-ray OFF” is flashing and the color of the “X-ray OFF”- button changes from a lighter shade of red to dark red.

7.1.1 Main window „xs|control“



Main window: xs|control

ON	**1**	Starts X-ray production, restarts processes, for example warm-up aborted due to opening the Interlock circuit).
OFF	**2**	Stops X-ray production or aborts a running process (for instance warm-up, centering)
High Voltage Settings		
Slider	**3**	Slider for setting high voltage values
Input field	**4**	Direct input of high voltage value
Button +- 10kV	**5**	Increases or decreases high voltage by +10 or –10kV with every click.
Button +- 1kV	**6**	Increases or decreases high voltage by +1 or –1 kV with every click.
Tube Current Settings		
Slider	**7**	Slider for setting tube current values
Input field	**8**	Direct input of tube current value
Button ± 10µA	**9**	Increases or decreases the tube current by +10 or –10 µA with every click.
Button ± 1µA	**10**	Increases or decreases the tube current by +1 or –1µA

Setting the X-ray parameters

Setting the high voltage values:

Use the left one of the two sliders (kV) (3), the input field or the two buttons directly below the input field (4) to set the high voltage value. Use buttons (5+6) to adjust voltage by either 1 (6) or 10 kV (5). During system warm-up, the input fields display the X-ray unit's monitor values, provided they are not being used by the operator.

Setting the tube current values:

Use the right one of the two sliders (µA) (7), the input field (8) or the two buttons directly below the input field (9+10) to set the tube current. Use these buttons to adjust current by either 1 (10) or 10 kV (9). Invalid values are corrected by the X-ray unit

The tube current (µA) can be adjusted by the slider (7), the input field (8) or the two spin buttons (9+10) directly below the input field. The spin buttons adjust the tube voltage either by 1 (10) or 10 µA (9). Invalid values are automatically corrected by the X-ray unit (For example: With a voltage value of 160kV and a maximum output of 20 W, a current of 200 µA would be impossible- in this case, the highest possible value would be I=125µA).

Control displays

Beam LED	**11**	Indicates the beam status.
Beam Status **RED** **YELLOW** **GREEN**	**12**	 Off, no beam Warm-up, beam is being build up or centering, the beam is being centered Stable, beam is stable and focused
Power	**13**	Displays the beam power in Watt.
Target Power (optional)	**15**	Indicates target power in Watt (for the nanofocus tube head)
ISO	**14**	With this button activated, power is kept constant even if high voltage changes, that means that the tube current value is adjusted automatically in case high voltage changes.
Controls	**18**	Opens or closes a window offering additional control features.
Timer	**19**	Opens or closes window offering time control features.
OFF/ON	**22/ T1**	Indicates whether or not the timer is OFF, as per default, or ON (green). This display has the same function as the ON/OFF button in the "Timer"-window (T1).
Dose Ctrl. (optional)	**20**	Opens or closes the Dose Control-window.
Power Mode (optional)	**21**	Enables or disables the power mode (optional).

Optional feature: Beam Shutter

Shutter LED	**15**	Indicates the status of the beam shutter.
Shutter state **GREY** **YELLOW**		 Beam shutter off (beam is directed onto the target) Beam shutter on (beam is shut down, no radiation) -Electron beam is inside the beam shutter or was directed into the beam shutter during build up.
Shutter		Enables or disables the beam shutter.

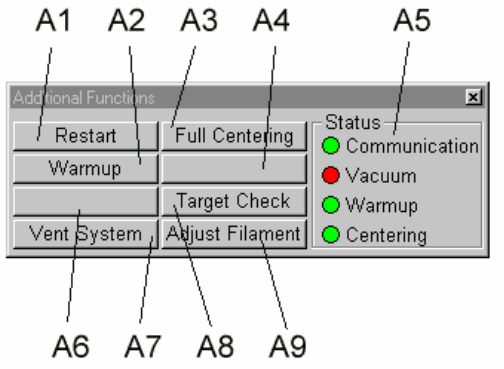
Optional feature: nanofocus™

The following buttons are available provided that your X-ray unit is supplied with a nanofocus™ tube head.

Tube mode	**24-27**	Indicates the currently active tube mode. Press the appropriate button to change the tube mode.
Focus optimization	**28-30**	May help improve resolution.
Focus display	**28**	The currently set focus within the range of [-5.0 to +5.0]
Mode 0 **Mode 1** **Mode 2** **Mode 3**	**24** **25** **26** **27**	power mode max. target output 2.7W nanofocus™-mode 1 max. target output 1.1W nanofocus™-mode 2 max. target output 0.8W nanofocus™-mode 3 max. target output 0.6W **The higher the mode number, the higher resolution.** We recommend starting out with mode 1 and then trying a higher one if performance or resolution is insufficient.
Button ± 0.5	**29**	Changes the focus in steps of +0.5 or –0.5
Button ± 0.1	**30**	Changes the focus in steps of +0.1 or –0.1
Store	**31**	Saves all changes made, which will then be available the next time.

7.1.2 Window- „Additional Functions“

Button 15 opens the control window „Additional Functions“, which provides access to additional features. Only buttons that are labeled are active.



„Additional Functions“

This window contains the following buttons:

ReStart	**A1**	Complete restart including tube evacuation, warm-up and adjustment of filament current.
Warm-up	**A2**	Tube is being warmed-up, maximum high voltage
Full Centering	**A3**	Starts complete auto-centering sequence using different high voltage values.
Adjust Filament	**A9**	Starts automatic adjustment of the filament current
Target Check (optional)	**A8**	Starts automatic target check (optional)
Vent system (optional)	**A6**	Vents tube .Use prior to starting maintenance work (replacing filament or target). After using “Vent system”, you must either switch the X-ray unit off or restart it by selecting “Restart”. **NOTE:** After tube venting is complete, do not forget to switch off the X-ray unit before starting any maintenance work!!

The following features are available only when X-radiation is being generated:

Centering	**A3**	Centers beam using currently set high-voltage. In case the X-ray unit is equipped with a second target, such as a rod anode, another button, **Centering 2** (A4), is available.
CONTINUE	**A6**	Resumes aborted processes such as incomplete warm-up through open interlock.
HALT	**A6**	Stops the process currently in progress, such as warm-up or centering.

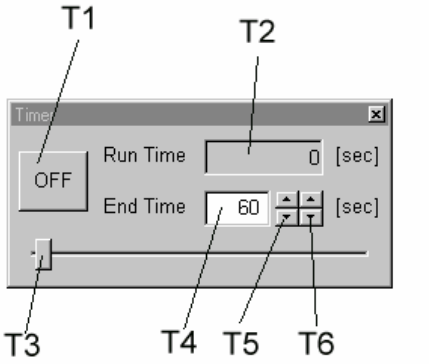
Status displays (Additional Functions)

Several status displays (A5) are available:

Communication	**A5**	Communication with system working o.k. (GREEN) or not (RED)
Vacuum	**A5**	Vacuum sufficient for operation (GREEN) or not (RED)
Warm-up	**A5**	System warm-up complete (GREEN) or still in progress/no warm-up (RED)
Centering	**A5**	Centering complete (GREEN) or still in progress/system not centered (RED)

7.1.3 Window „Timer“

Button No. 16 opens or closes the timer window for time-controlled X-ray generation.

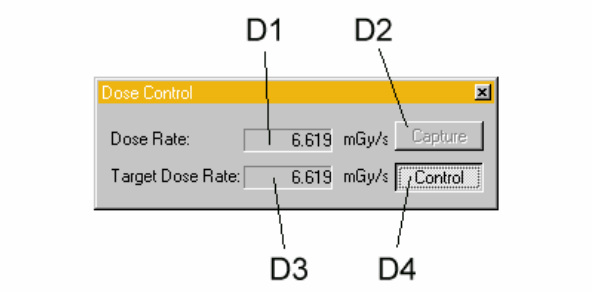


„Timer“ menu

ON/OFF	**22** **T1**	Indicates whether the timer is activated (ON) or deactivated (OFF). When ON, button T1 appears in green.
Run Time	**T2**	Indicates beam duration in seconds after switching on radiation regardless of the timer being activated or not.
End Time	**T4**	The set time limit can be varied using the slider (T3), input field (T4) and buttons in steps of ±10 (T5) or ±1 (T6) seconds. With the timer activated, radiation will be automatically turned off as soon as the set time limit is exceeded.

7.1.4 Window: Dose rate control (optional)

Press the “Dose Ctrl.” (20) button to open this window**.**



Window „Dose rate control“

Dose Rate	**D1**	Indicates the measured dose rate in nGy/s. This value is updated every second.
Capture	**D2**	Press this button to make the currently displayed dose rate value your target value.
Target Dose Rate	**D3**	Indicates the target dose rate selected using “Capture” (see above).
Control	**D4**	This button activates the dose rate control function (provided it is available). A “pressed” button indicates that dose rate control is active. The dose rate control option is only available if the beam is stable and not inside the beam shutter. In case dose rate control is activated, but the beam no longer stable (for instance, if high voltage value was changed) or inside the shutter, dose rate control will be switched off automatically.

The dose rate control function compensates for dose fluctuations by adjusting the tube current. In case the tube current differs by more than 10% from the initial value, the dose rate control function is switched off automatically.

7.1.5 Optional feature: Power Mode

If the X-ray unit is equipped with this feature, you may upload an advanced characteristic curve. When the “Pmode- ” button appears pressed, the X-ray unit is currently running in power mode. Otherwise, the X-ray unit is running in default mode. A disabled, greyed out button means that your X-ray unit is not equipped with the power mode.

Improper use of the power mode may result in system damage!

7.2 Operating instructions

7.2.1 Priority of „X-Ray OFF”

Due to safety reasons, the X-Ray OFF-function has priority at all times. Pressing the “X-Ray OFF”-button will cause X-ray generation to be aborted at any time.

7.2.2 Setting high voltage and tube current

It is crucial to set both high voltage and tube current according to the evaluation task at hand, while simultaneously optimizing image sharpness, contrast and noise.

Start out with small beam powers (for instance: 60kV- 20µA). With beam power values exceeding 4 W, the focus widens in order to prevent burn damage on the target. The focal size is at all times optimally adjusted to the target’s capacity.

7.2.3 System initialization

After starting or restarting the X-ray unit, X-ray control automatically initializes. The initialization process consists of the following steps:

- Evacuation of the tube
- Conditioning of the X-Ray tube (warm-up)
- Automatic filament adjustment
- Auto-centering sequence
- Target check (optional)

After initialization is complete, the X-ray unit is now ready to use.

7.2.4 Tube warm-up

The conditioning process is necessary to ensure that the tube is stable to high voltages. During this process, the X-ray unit is powered up until reaching the maximum high voltage possible, but no electron beam is build up. The conditioning process may be aborted before the maximum high voltage is reached by pressing the HALT- button. This value is now the new maximum high voltage value.

From time to time, a second warm-up may become necessary due to fluctuating beam parameters such as high voltage or tube current

7.2.5 Auto-Centering

In order for the X-ray unit to work in a stable manner, it is crucial for the electron beam to be centered. Therefore, an automatic centering process, over the entire high-voltage range, is performed as part of the initialization process (see 8.2.3.:X-ray unit initialization).

It is possible to repeat the auto-centering sequence (Button “Full Centering” (A3) in the “Additional Functions”-menu) any time, for instance after image problems or after a filament was replaced. Furthermore, the user may start the automatic centering process from any high-voltage value using the “Centering” function (only available when X-ray generation in progress).

7.2.6 Target Check

X-ray units featuring a transmission target may come with the target check feature, which can be used to check the target for burn-ins, which may occur over time. If necessary, the user will be automatically advised to set a new position on the target. (See Setting a new target position). This procedure can be started at any time by selecting button A8 from the “ Additional functions” menu in the xs|control interface.

7.2.7 Venting the tube for maintenance purposes

Provided the X-ray unit is equipped with advanced vacuum control, the venting process, necessary prior to replacing the plug-in cathode or performing maintenance work, can be started via the software (see "Additional functions", button A7 "Vent system").

7.3 Fault Indicators and Error List

Errors, if any, are displayed for 10 seconds in field 18 in the main window. Click into this field to activate or deactivate a summary listing all errors that have occurred to this point in chronological order.

Furthermore, all other errors and potentially important service information is located in the LOG-file "XS-CONTROL.LOG" (Directory: "Installation"). If the X-ray unit needs repairing or servicing, this file enables fast diagnosis.

7.4 Installation Instructions

For installation of the xs|control software, start the setup.exe program in the xs-control archive. The installation program creates a file directory "phoenix x-ray\xs control" in the program folder and copies the necessary files into the directory. The user will be asked to select either the English or the German manual. The appropriate pdf-file is located in the "Program"- folder. Furthermore, the program creates two shortcuts; one on the desktop and one in the "Program"-folder. These shortcuts use a communications driver (add-on program) to select either COM1 or COM2 for communication with the X-ray unit. If another interface or no interface at all (in case a communication driver is already installed) is selected, change the additional parameter "/Q0" in the shortcuts (see below). The X-ray unit may be de-installed via the X-ray unit control".

Default parameters:

Start xs|control with the additional parameter (/Q0, /Q1 or /Q2). The additional parameter describes the serial port (COM1 or COM2) or the communications driver through which the PC communicates with the X-ray control.

Serial port:	COM2	*xs-control.exe /Q2*
	COM1	*xs-control.exe /Q1*
	Driver	*xs-control.exe /Q0*
	Driver opt. COM	*xs-control.exe*

If there is no driver, the program automatically selects COM2 after a few seconds.

For nanofocus systems (optional), the default mode can be pre-selected in the line "Option /M0…/M3". The default mode is the focal mode in which the tube wakes up after being started or restarted. Per default (without an additional parameter), the X-ray unit wakes up in mode 1.

Default mode:	mode 0:	*xs-control.exe /M0*
	mode 1:	*xs-control.exe /M1* or *xs-control.exe*
	mode 2:	*xs-control.exe /M2*
	mode 3:	*xs-control.exe /M3*

In case of communication problems:

It might become necessary to insert "/NOSERIALMICE" into the boot.ini (NT4.0) file in order to prevent the program from interpreting entries that already existed when the operating system was booted up as mouse commands. Otherwise, the operating system might occupy the serial interface.

8 Causes of failure and trouble-shooting

Error: The X-ray unit cannot be turned on.

Possible causes:

- The X-ray unit is cut off from the main power supply
- The main switch is not set to ON.
- The “Emergency OFF” -switch is enabled.
- The key switch is not set to “ON”, or it was not set to OFF after using the emergency stop switch.
- A fuse is blown. Check components for irregularities and overheating. In case of overheating contact our service department. If that’s not the case, check cables for firm attachment. Then replace the blown fuse and press it back into its slot and start the X-ray unit. Repeated blowing of the fuse indicates an underlying defect. **In this event, immediately switch off the X-ray unit and contact our customer service department.**

Error: X-ray generation does not work.

Possible causes:

- The door of the radiation protection cabinet is not firmly shut.
- One of the warning lights is defective and the bulb needs replacing.

If none of these causes apply, the X-ray tube or X-ray control could be defective.

In this case: Immediately switch off the X-ray unit and contact our Customer Service Department !!

9 Lubricants and Cleaning Agents

Description	Name	Usage	Amount
Silicon grease	Silicon Grease 704	High voltage cable	app. 100 g/3.53 oz
Lubricating grease	Lithium soap grease KP2K (DIN 51825) consistency class NLGI 2 (DIN 51818)	Manipulator guide tracks	app. 50 g/1.76 oz
High voltage oil (optional)	Shell Diala Oil BG	High voltage generators	app. 80 liters

CAUTION

For information on how to handle, store and dispose of lubricants and cleaning agents, please consult the appropriate MSDS data sheets.

10 Special Substances

Name	Usage	Amount
Beryllium	X-ray tube exit window	app. 4 g/0.14 oz
Lead	Radiation protection cabinet	Up to 1300 kg/2865.98 lb

DANGER

Beryllium is a potential health hazard.

The exit window of the X-ray tube is made of beryllium. In case of beryllium window damage or breakage, immediately switch off the X-ray unit and contact our Customer Service Department for proper disposal. Beryllium particles, especially powder or dust, which may result from a breakage, are harmful to the human body. Use extreme caution to prevent inhaling airborne beryllium, since this may cause respiratory problems.

In case you would like to dispose of the tube, please contact our customer service department..

DANGER

Lead is a potential health hazard

The radiation protection cabinet has a lead shield.
When working with lead, dangerous substances can be released. Never inhale or ingest neither lead nor its inorganic compounds. For information on how to dispose of the radiation safety cabinet, contact our Customer Service Department.

CAUTION

For information on how to handle, store and dispose of the substances detailed above, please consult the appropriate MSDS data sheets.

11 Maintenance

WARNING

Cleansing, greasing and maintenance may be performed by authorized, trained individuals only in compliance with the instructions of the maintenance manual and the applicable accident prevention laws.

11.1 Safety Precautions

To protect the X-ray unit against unauthorized access or unintentional activation (for instance during maintenance) proceed as follows:

- Inform everybody concerned of the maintenance work.
- Click the “OFF”- button in the X-ray control section in the software main window.
- Exit all programs and close Windows.
- Set the key switch to “0”. The X-ray unit is now off. Remove the key and store it in a safe place.
- Set the main switch to „OFF“(0). The X-ray unit is now completely shut down and cut off from the grid (except for the power supply filter). Secure the switch with a padlock.
- Remove the key and store it in a safe place.
- Make sure no-one remains on the X-ray unit.
- Make sure the X-ray unit is completely switched off by trying to restart it.
- Put up a sign indicating until when the X-ray unit will be out of service.

Once maintenance is complete and the X-ray unit in perfect working order:

- Take down the sign.
- Make sure nobody remains on the X-ray unit.
- Take off the padlock.
- Set the main switch to „ON“(I).
  The X-ray unit is now reconnected to the main power supply.
- Now, set the key switch to „ON“.
  The X-ray unit is now in operating mode. Provided the door is shut, initialization will now automatically start.
- Inform everybody concerned that the X-ray unit is back in service.

11.2 Maintenance Schedule

Location	Maintenance Intervals	See Chapter
Replacing the filament	As needed	Replacing the plug-in cathode
Changing the target position	As needed	Setting a new target position
Replacing the target	As needed	Replacing the target
Maintenance of the high-voltage cable	Every 6 months	Maintaining the high-voltage cable
Lubricant reservoir/turbo-molecular pump (optional)	Once a year	Maintaining the vacuum system
Manipulator	Every 6 months	Maintaining the manipulator
Radiation protection cabinet	Monthly	Cabinet maintenance

12 Servicing the X-ray tube

WARNING

Maintenance work may be performed by authorized, trained individuals only in compliance with the maintenance instructions of this manual and the applicable accident prevention laws.

12.1 Replacing the plug-in cathode

CAUTION

Always be extremely careful when opening the tube and replacing the cathode!
The sensitive surfaces must not be contaminated or scratched!

WARNING

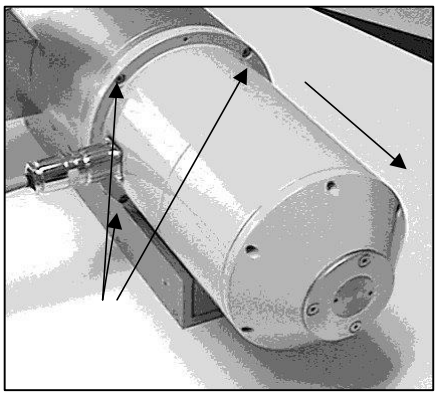
Never open the X-ray tube unless the X-ray unit is completely turned off.

It is usually necessary to exchange the plug-in cathode, if the filament inside the cathode is either blown or worn out, both of which is often announced by an increasingly worse image quality.

Please be extremely careful when replacing the plug-in cathode, since, for replacing the cathode, you will have to touch the highly sensitive high-voltage electrodes!

Please perform the following steps in this exact order:

- Move the manipulator X-ray unit into bottommost position so that the tube can be opened.
- Vent the X-ray unit by selecting “VentSystem”, button A 7 in the “Additional Functions”- menu, see Section 7.1.2 (will take app. 30 seconds).
- Shut down system PC and turn off the X-ray unit.
- Remove the four hexagon socket head cap screws (see image on the right).
- Gently pull the tube head downwards using your hands. Initially, you will probably have to apply some force since there might be some residual vacuum left in the tube. You might have to unscrew the tube connector.



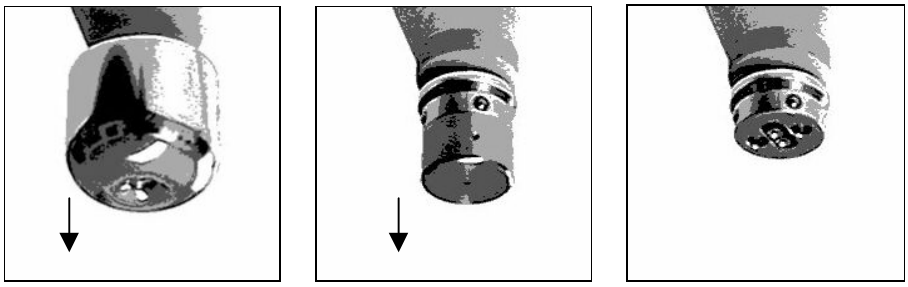
WARNING

Both grid and cathode can get very hot! Use the heat-resistant and lint-free gloves provided by the manufacturer to handle hot parts!

CAUTION

The grid surface is very sensitive. Always wear lint-free gloves or use lint-free cloths when handling the grid or other surfaces of the high-voltage case.

- Put on the pair of clean, lint-free gloves provided by phoenix|x-ray. Carefully pull grid cap downwards to remove it. Place grid cap on a clean, dust-free cloth.
- Pull plug-in cathode downwards to remove it. Remove plug-in cathode.



- Insert new, clean plug-in cathode into socket. Make sure to insert both pins.
- Check cathode and socket for flush fit. If necessary, rotate cathode 180 degrees and check again.
- Reinsert grid cap and carefully lock in place.
- Clean the insides of the high-voltage case and the anode plate using a lint-free cloth.
- Close the X-ray tube and fasten the four hexagon socket head cap screws. If necessary, fasten the tube connector.
- Switch on X-ray unit and wait for initialization to finish. This process may take slightly longer than usual due to the fact that evacuation and conditioning processes take longer than usual after the tube has been vented.

12.2 Setting a new target position

CAUTION

The X-ray tube window consists of beryllium. Do not touch the window with bare hands. If the window needs to be disposed of, observe the applicable laws and regulations or contact phoenix|x-ray.

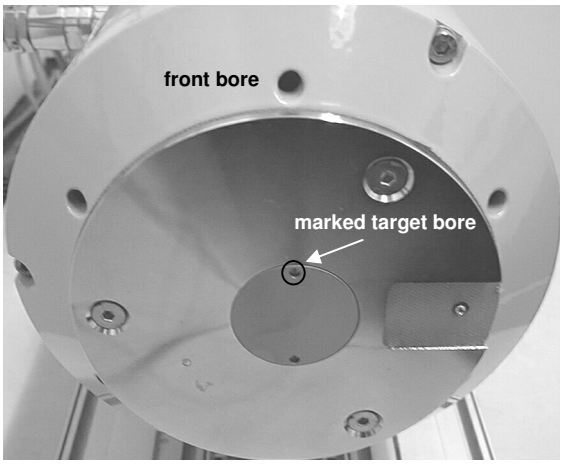
Setting a new target position becomes necessary, if image quality has suffered. It is not necessary to vent the tube prior to changing the target position.

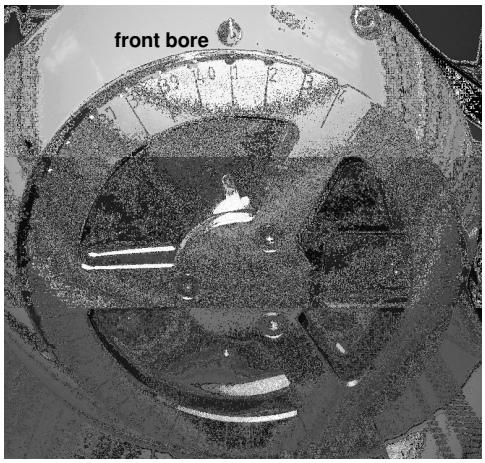
The target is mounted eccentrically inside the tube head. Therefore, by rotating the target, several locations on the target surface may serve as focal points.

To set a new target position, proceed as follows:

- Switch off radiation.
- Move the manipulator X-ray unit into bottommost position.
- Unscrew the 3 hexagon socket head cap screws (size 3) of the target retaining plate **one** turn (Loosen collimator, if necessary.)
- Rotate target in counterclockwise direction using the supplied turning tool. At this, follow the consecutive numbering on the turning tool (see images below).
- Fasten the three hexagon socket head cap screws firmly on the target retaining plate. Now, the target is in position.
- The X-ray unit is now ready to operate.
- Execute target check to see whether changing the target position was successful.

NOTE: When the X-ray-system is delivered, the marking ‘1’ on the turning tool aligns with the front bore in the tube’s head. Also one of the two bores in the target is marked. This helps properly setting the up to 40 different target positions. The images below show the tube head with target and turning tool. Target is in position ‘focal point 1’.





12.3 Replacing the Transmission Target

CAUTION

The X-Ray tube window consists of beryllium. Never touch the window with bare hands. If the window needs to be disposed of, comply with the applicable laws and regulations or contact the phoenix|x-ray Customer Service Department.

CAUTION

Be extremely careful when opening the X-ray tube! The sensitive surfaces must never be damaged under any circumstance!

WARNING

Never open the tube while the X-ray unit is still running.

Replacing the target becomes necessary when the target is worn out, e.g. when there are no more “fresh” target positions available. Before replacing the target, the X-ray unit has to be vented and switched off.

To replace the target, please proceed as follows:

- Turn off radiation.
- Move manipulator X-ray unit into bottommost position.
- Vent X-ray unit using “VentSystem” (will take app. 30 seconds)
- Shut down PC and switch off X-ray unit
- Unscrew the 3 hexagon socket head cap screws (size 3) on the target retaining plate. Loosen the collimator, if necessary.
- Remove target and target retaining plate carefully and secure against dropping and damaging the detector.
- Check backscatter aperture (10-mm-wide ring inside the tube head) and, if necessary, clean area carefully using acetone.

PLEASE NOTE: Acetone damages the tube’s yellow powder coat. Acetone must never come in contact with the tube coat.

- If necessary, clean O-ring and O-ring groove inside the head and re-insert O-ring.
- Clean new target with alcohol and insert into target retaining plate. Fasten both parts to the tube head using the three hexagon socket head cap screws (there is only one possible position). Be careful to tighten screws evenly to avoid distortions.
- Set target to position ‘focal point 1’. (see section “Setting a new target position”)
- Switch X-ray unit on and wait for initialization to finish. This process may take slightly longer than usual, since the tube has been vented causing evacuation and warm-up to take longer than usual.

12.4 Servicing the high-voltage cable

WARNING

Cleansing, greasing and maintenance may be performed by authorized, trained individuals only, in compliance with the instructions of the maintenance manual and the applicable accident prevention laws!

WARNING

ALWAYS switch off the X-ray unit before touching the high-voltage cable !!

Due to wear and tear, the high-voltage cable will need greasing every six months. Never use anything but the silicon grease provided by the manufacturer! The high-voltage cables have flanges for adjusting the required preload for the rubber cone.

Please proceed as follows (for each end of the high-voltage cable):

- Isolate X-ray unit from the power grid (galvanic isolation)
- Evenly unscrew the 4 hexagon socket head cap screws on each flange
- Carefully pull out both ends of the high-voltage cable.
- Remove excess grease from cable cone.
- Clean cable cone including contacts with alcohol.
- Grease the high-voltage cable using app. 3 cm of silicon grease (use 3 cm for 160 kV, 5 cm for 200/225 kV).. Distribute grease evenly on cone. Make sure that no grease touches the contacts.
- Carefully re-insert cable into both sockets. Make sure that contact tips do not touch the grease.
- Check preload; the space between cable and flange must be 5-6 mm wide each. Press the cable as far as possible into the flange. Should the space be more or less than 5-6 mm wide, rotate the cable flange (unscrew 3 setscrews on the flange) to adjust.
- Fasten cable in the flange with the four hexagon socket head cap screws until space is 0 mm wide. If necessary, fasten setscrews on the flange.
- After both cable ends have been greased, check X-ray unit for proper condition and restart

13 Servicing the Vacuum System (Option)

WARNING

Cleansing, greasing and maintenance may be performed by authorized, trained individuals only, in compliance with the instructions of the maintenance manual and the applicable accident prevention laws!

13.1 Replacing the lubricant reservoir

CAUTION

Replacing the lubricant reservoir requires opening the turbo-molecular pump. Only open the turbo-molecular pump in a clean and lint-free environment.

WARNING

Always make sure that the X-ray unit is completely turned off and shut down before opening any of the service lids.

WARNING

Always make sure that all service lids are firmly shut before starting up the X-ray unit. Double check all lids and doors to prevent radiation leakage.

You will need the following tools:

- Hollow hexagon wrench, size 3
- Hollow hexagon wrench, size 4
- Face pin spanner wrench, size 2
- 2 pointed screwdrivers or pocket knives
- Lubricant reservoir Pfeiffer PM 073 073 T
  (You won't need the plastic lid with sealing ring enclosed in the service kit provided by the manufacturer.)

In accordance with the manufacturer's instructions, we recommend replacing the lubricant reservoir once a year.

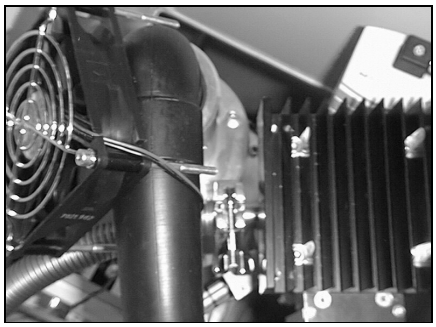
CAUTION

We are not liable for injury, damage or breakdown caused by improperly performed maintenance. In this event, all warranties become void!

To replace the lubricant reservoir, proceed as follows:

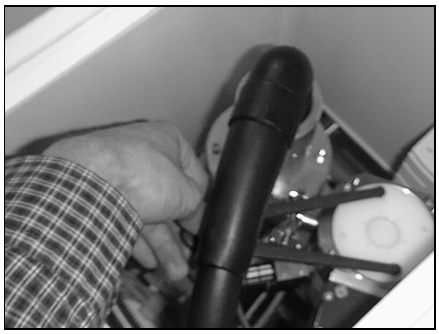
- Vent x-ray-tube and vacuum system by clicking "VENT system". This will take approximately 30 seconds.
- Before starting maintenance, completely turn off the X-ray unit. Proceed as follows: Shut down the computer and set both the key-switch and the main switch to OFF.
- Open the appropriate service lid to access the turbo-molecular pump.
- Unscrew the 4 screws connecting fan and heat sink (Hollow hexagon wrench, Size 3), but do not remove. Disconnect the plug connector to the fan's power supply and remove fan.

Rear end of the X-ray tube with the high-voltage connector in the center and, to the right, turbo- molecular pump with heat sink. The fan is already removed.



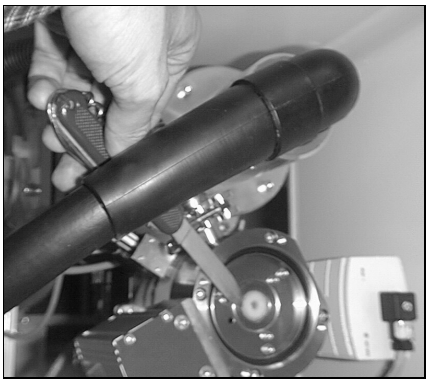
- Unscrew the 4 screws connecting heat sink and turbo-molecular pump, using the hollow hexagon wrench in size 4. The screws are located between the fins of the heat sink.
- Rotate the lid (plastic, white) of the turbo-molecular pump counter clockwise using a face pin spanner wrench and remove it.

The pump lid is being unscrewed using a face pin spanner wrench.



- Take two pointed screwdrivers or pocket knives and place them on the lubricant reservoir to lift it out of the turbo-molecular pump as shown in the next picture. This might require some force and skill.

The lubricant reservoir is being lifted out of the pump using two pocket knives.



- Carefully insert new lubricant reservoir into turbo molecular pump. The lubricant reservoir is properly inserted when the O-ring is no longer visible.
- Make sure that the turbo-molecular pump's lubrication ring is free of dirt and not otherwise contaminated. Carefully re-insert lid and fasten it using the face pin spanner wrench.
- Mount heat sink onto turbo-molecular pump.
- Mount fan onto heat sink. Connect fan to power supply.
- Start X-ray unit and check for proper operation of the vacuum system

14 Servicing the Manipulator

WARNING

Cleansing, greasing and maintenance may be performed by authorized, trained individuals only, in compliance with the instructions of the maintenance manual and the applicable accident prevention laws!

14.1 Lubricants

Use the following lubricant:

Description	Manufacturer
Lithium Soap Grease KP2K (DIN 51825) Consistency Class NLGI 2 (DIN 51818)	e.g.: Klueber/Isoflex NCA 15 or Shell/Alvania Fett G2

CAUTION

Grease containing solid lubricants (e. g. graphite and MoS2-additives) must not be used!)

Where to lubricate	Interval
X-axis	6 months
Z-axis	6 months
Z-axis	6 months

Note:

Maintenance cycles are based on 1- shift-a-day operation. In case of multiple-shift operation, it is necessary to re-grease the components in shorter intervals.

14.2 Manipulator

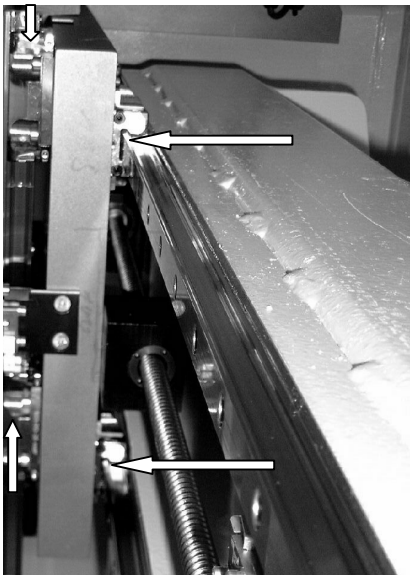
The manipulation system is lubricated by the manufacturer prior to shipping. On-site maintenance includes re-greasing and, if necessary, cleaning the guide tracks and spindles in the intervals detailed in the maintenance schedule.

Re-greasing the X-axis

- Move manipulator into centric position
- Clean spindles and track guides using a lint free cloth
- Grease the spindle slightly and re-grease the spindle nut through the grease nipple
- Grease the track guides slightly and re-grease the runner blocks through the grease fittings on the end sides.

Re-greasing the Z-axis

- Move manipulator into centric position
- Clean spindles and track guides with a lint free cloth
- Grease the spindle slightly and re-grease the spindle nut through the grease fitting
- Grease the track guides slightly and re-grease the runner blocks through the grease fittings on the end sides.

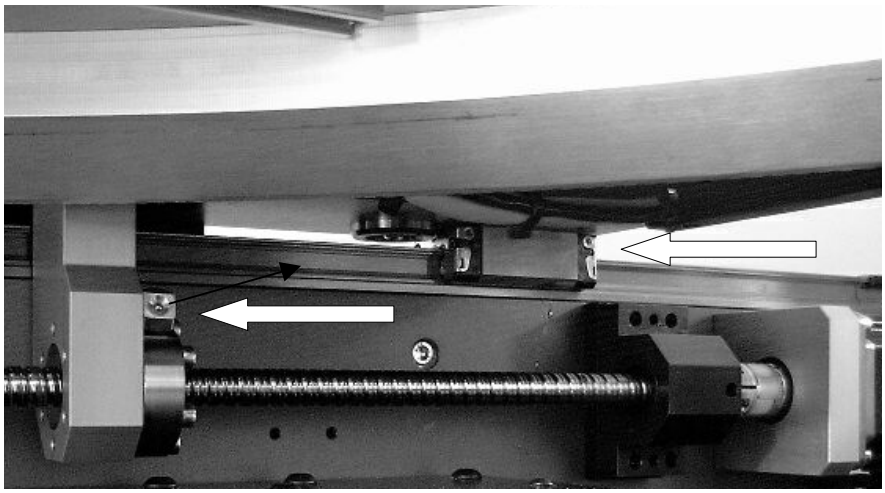


Runner block grease fittings

Position of the spindle nut grease fittings

Re-greasing the Y-axis

- Move manipulator back and up until close below the tube
- Clean spindles and track guides with a lint free cloth
- Grease the spindle slightly and re-grease the spindle nut through the grease fitting
- Grease the track guides slightly and re-grease the runner blocks through the grease fittings on the end sides



15 Servicing the radiation protection cabinet

WARNING

Cleansing, greasing and maintenance may be performed by authorized, trained individuals only, in compliance with the instructions of the maintenance manual and the applicable accident prevention laws!

15.1 Lubricants and Cleaning Agents

The following lubricants and cleansing agents will be used:

	Name	Manufacturer/ Brand name
A	Mild cleaning agent	
B	Lubricating oil CLP (DIN 515117, part 3)	e.g. Optimol / Longtime PD 00

Location/part	Lubricant/Cleaning agent	Interval
Cabinet		Once a month
Lead glass pane	A	As needed
Loading door	B	As needed

15.2 Cabinet

At least once a month, check the radiation protection cabinet for the following:

- Damage on the outside of the cabinet
- Damage of the lead insulation (shielding) of the cabinet.

In case of such damage, immediately inform your radiation safety officer and, if necessary, phoenix|x-ray.

15.3 Lead glass window

Due to its high content in lead oxide, the lead glass window of the cabinet is very sensitive to scratching, acids and lye. Never use anything but water, mild cleaning agents and a soft cloth to clean the lead glass window.

Make sure to check the lead glass window for damage as often as possible.

In case of damage, immediately inform your radiation safety officer and, if necessary, phoenix|x-ray.

15.4 Loading door

Clean the door guides as needed using a dry, soft cloth and oil slightly. How often this will be necessary strongly depends on the on-site operating conditions.

16 Spare parts

All components of this system are very reliable. Therefore, only a small number of maintenance and spare parts are needed.

Your X-ray unit comes with the following spare parts:

- Special gloves
- Special wipes
- Light bulb for warning light
- Fuses (1 set)
- O-rings (1 set)
- High-voltage grease (silicon grease)
- Optional: Maintenance kit with lubricants
- Optional: Maintenance kit for turbo-molecular pump

Consumable parts:

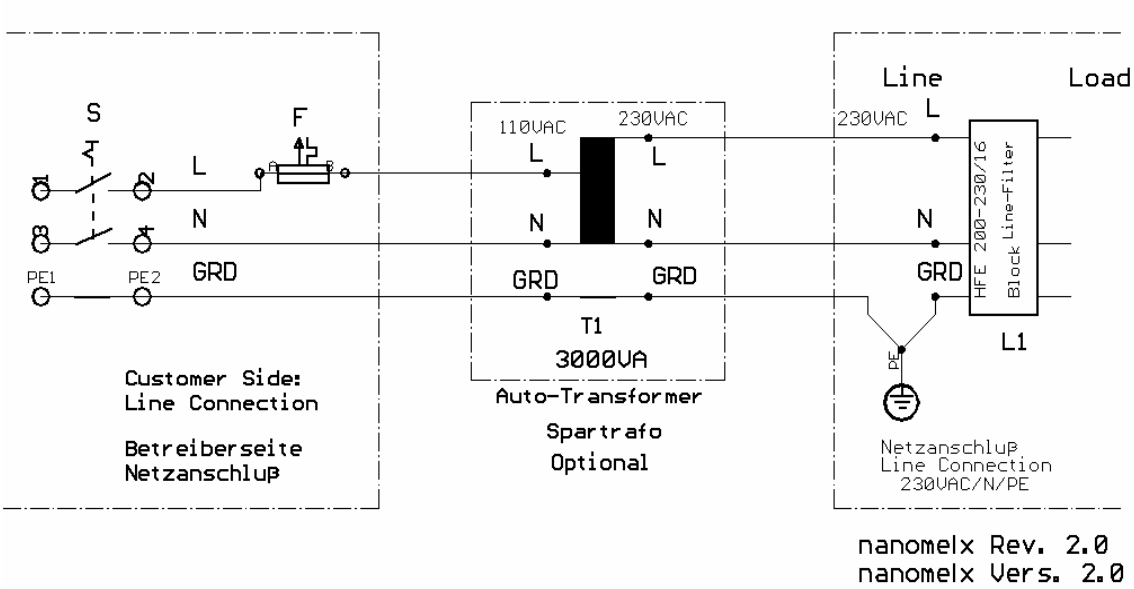
- 4 pre-adjusted plug-in cathodes

1 tool set:

- 1 set of hexagon socket head cap wrenches
- 1 target turning tool

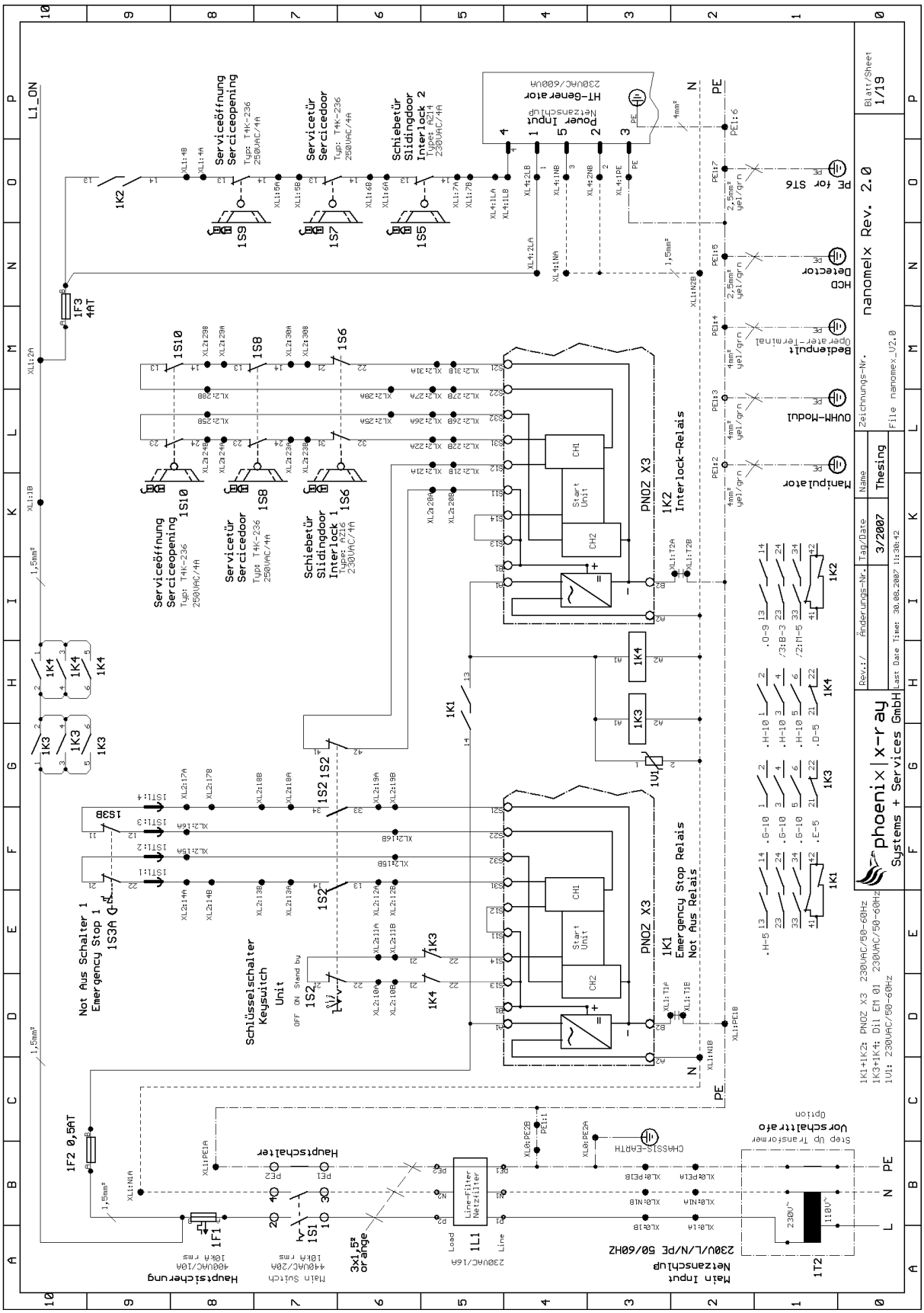
17 Appendix

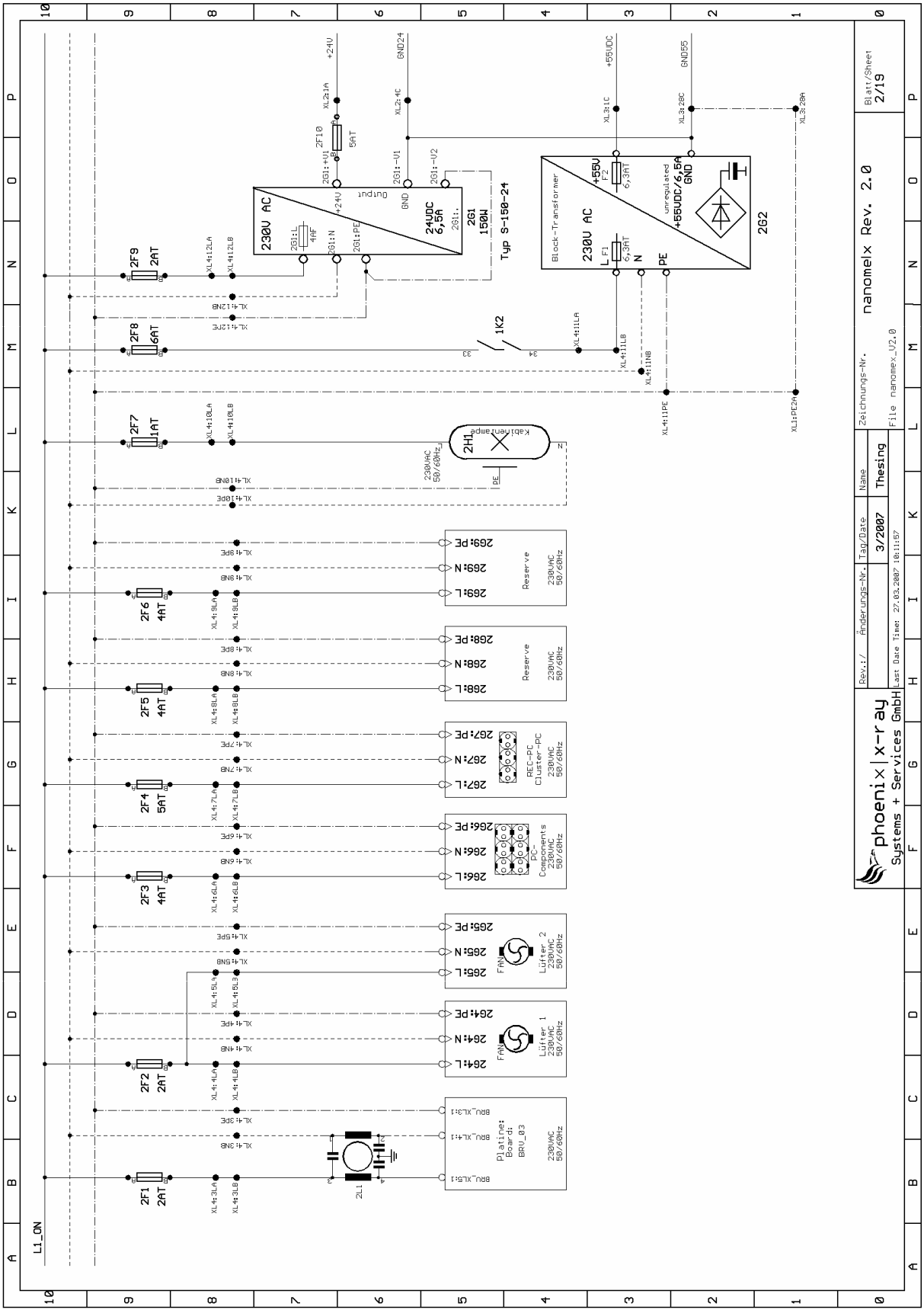
17.1 Connection to Supply Line



Note: Connect X-ray system exactly as indicated here. Failure to do so may cause system damage!

17.2 Wire diagrams




phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
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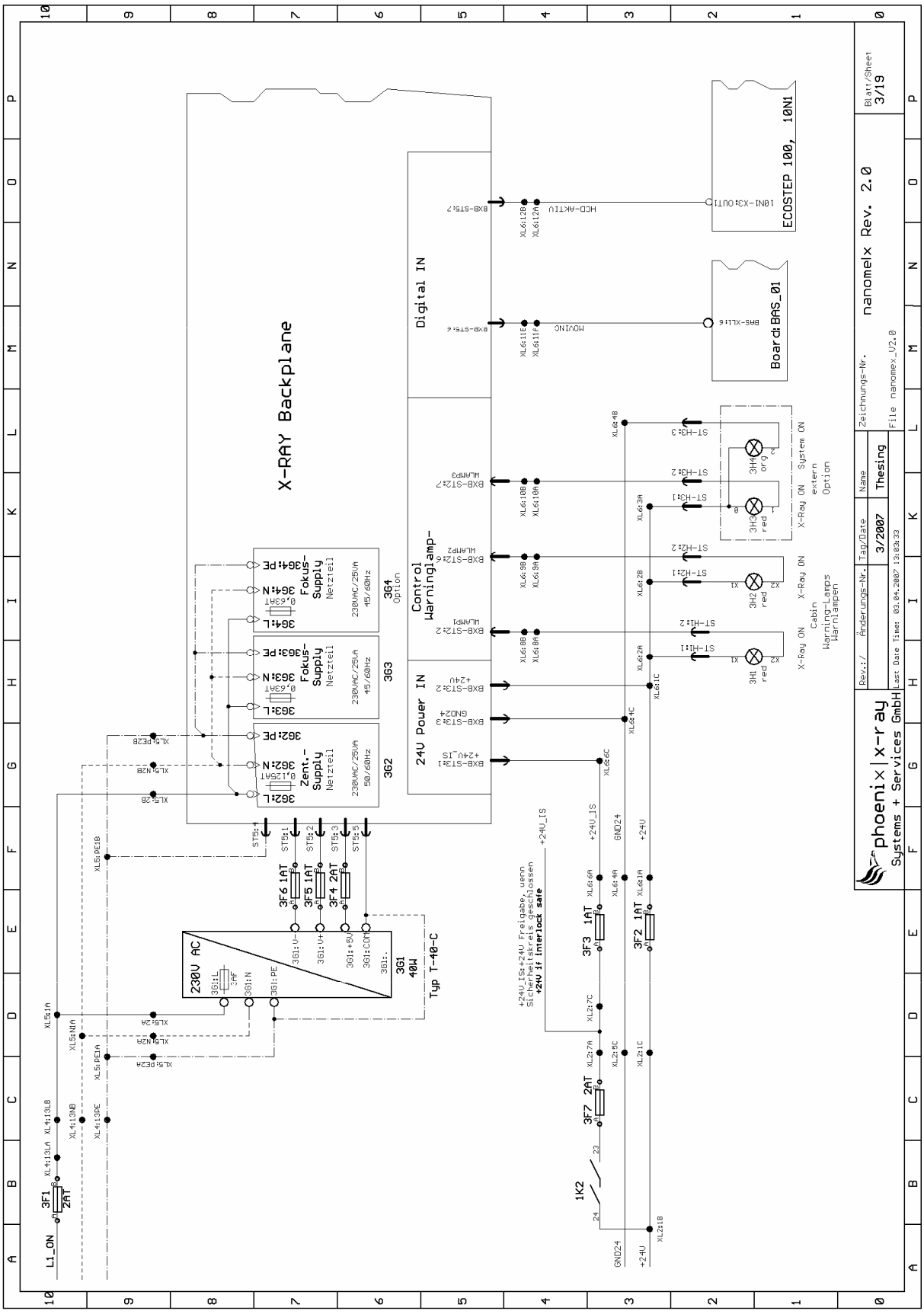
Zeichnungs-Nr.
File nanomex_V2.0
Name Thesing
Tag/Date 3/2007
Änderungs-Nr.
Rev.: /
Last Date Time: 27.03.2007 10:11:57
230V AC
24VDC 6,5A
2G1 150W
Typ S-150-24
Block-Transformer
230V AC
+55V F2 6,3AT
unregulated +66VDC/6,6A GND
2G2
1K2
2H1 Kabinenlampe
Reserve
REC-PC Cluster-PC
DC Components
Lüfter 2
Lüfter 1
Platine: Board: BRU_03
230VAC 50/60Hz
L1_ON


X-RAY Backplane
Digital IN
Control Warninglamp-
24V Power IN
ECOSTEP 100, 10N1
Board:BAS_01
nanome|x Rev. 2.0
phoenix | x-ray
Systems + Services GmbH
Thesing
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Zeichnungs-Nr.
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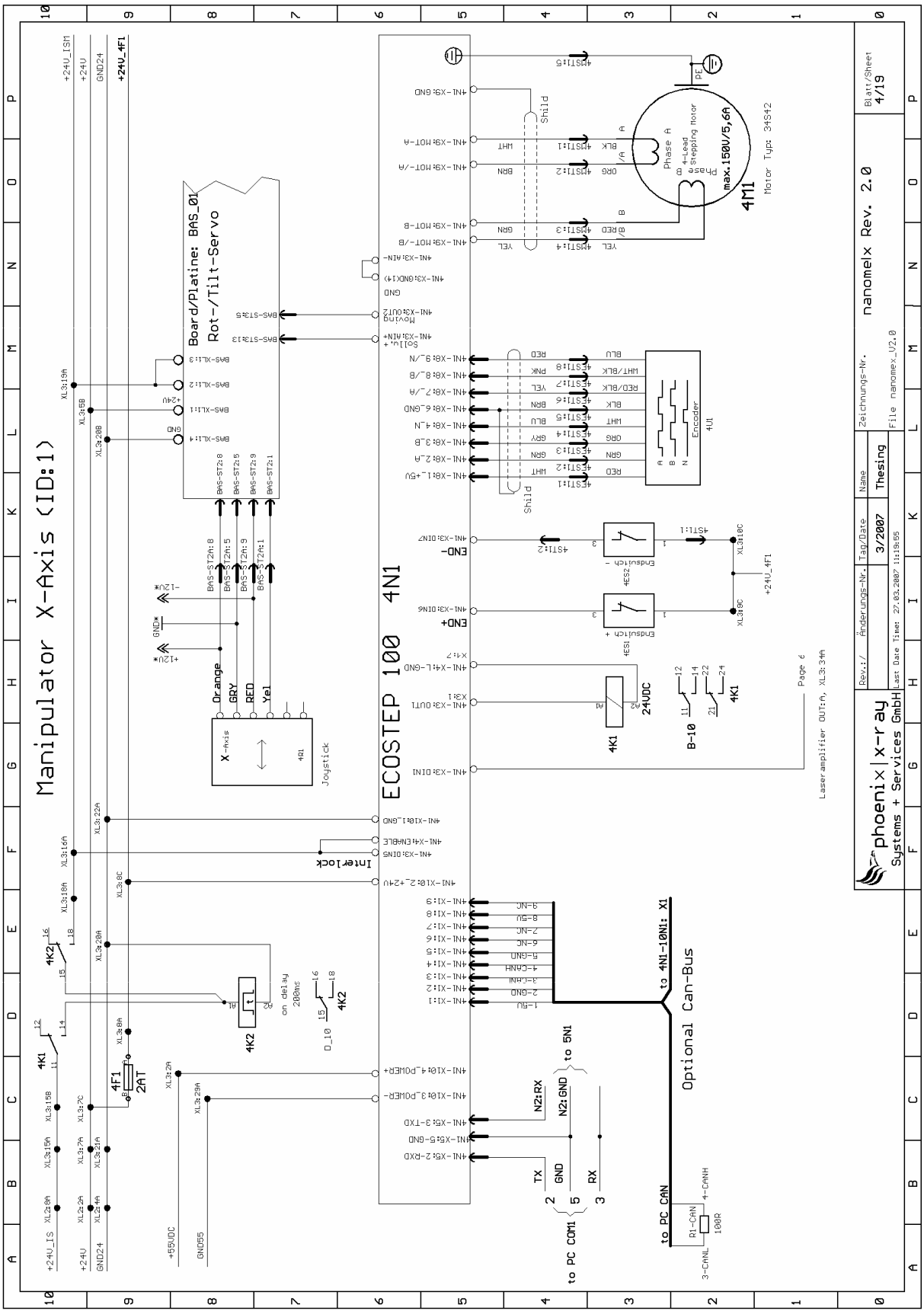
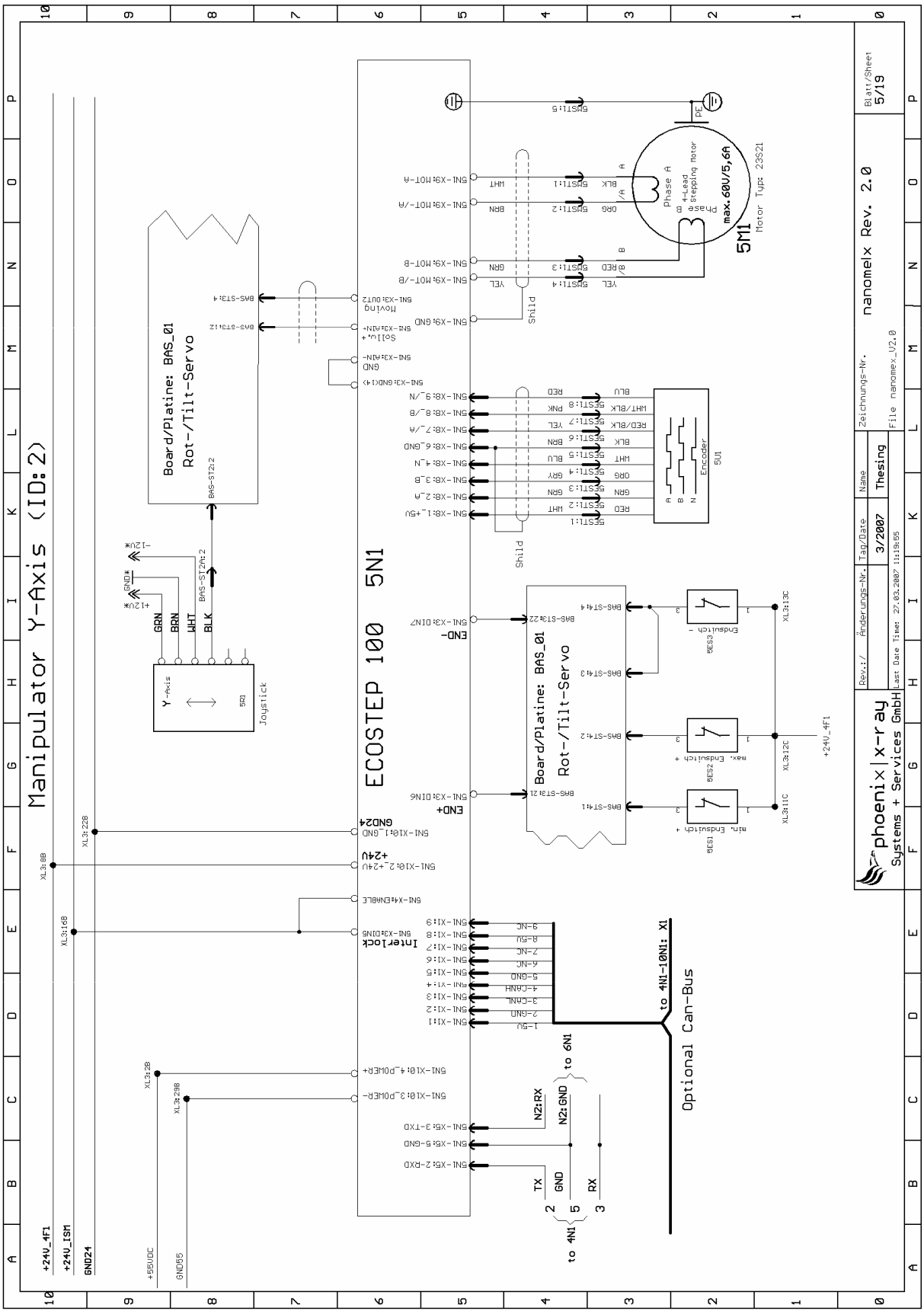
Tag/Date
Name
Last Date Time: 03.04.2007 13:03:33
230V AC
Typ T-40-C
3G1
40W
Zent.- Supply Netzteil
Fokus- Supply Netzteil
230VAC/25VA
45/60Hz
50/60Hz
3G4 Option
3F1 2AT
3F2 1AT
3F3 1AT
3F4 2AT
3F5 1AT
3F6 1AT
3F7 2AT
1K2
3H1 red
3H2 red
3H3 org
3H4 org
X-Ray ON
X-Ray ON
System ON
extern
Option
Cabin Warning-Lamps Warnlampen
+24U_IS+24U Freigabe, wenn Sicherheitskreis geschlossen
+24V if interlock safe
L1_ON
+24U_IS
GND24
+24U
HCD-AKTIV
MOVING


Manipulator X-Axis (ID:1)
ECOSTEP 100 4N1
Board/Platine: BAS_01
Rot-/Tilt-Servo
nanome|x Rev. 2.0
phoenix | x-ray
Systems + Services GmbH
Optional Can-Bus
to 4N1-10N1: X1
to PC CAN
to PC COM1
Interlock
Joystick
X-Axis
Encoder
4M1
Motor Typ: 34S42
max.150U/5,6A
24VDC
4K1
4K2
B-10
4F1
2AT
Thesing
3/2007
Page 6
Laseramplifier OUT:A, XL3:34A


Manipulator Y-Axis (ID:2)
ECOSTEP 100 5N1
Board/Platine: BAS_01
Rot-/Tilt-Servo
Joystick
Y-Axis
Encoder
5M1
max. 60V/5,6A
Motor Typ: 23S21
Optional Can-Bus
to 4N1-10N1: X1
Interlock
END+
END-
GND24
+24V
+24V_4F1
+24V_1SM
GND24
+55VDC
GND55
TX
GND
RX
N2:RX
N2:GND
to 6N1
to 4N1
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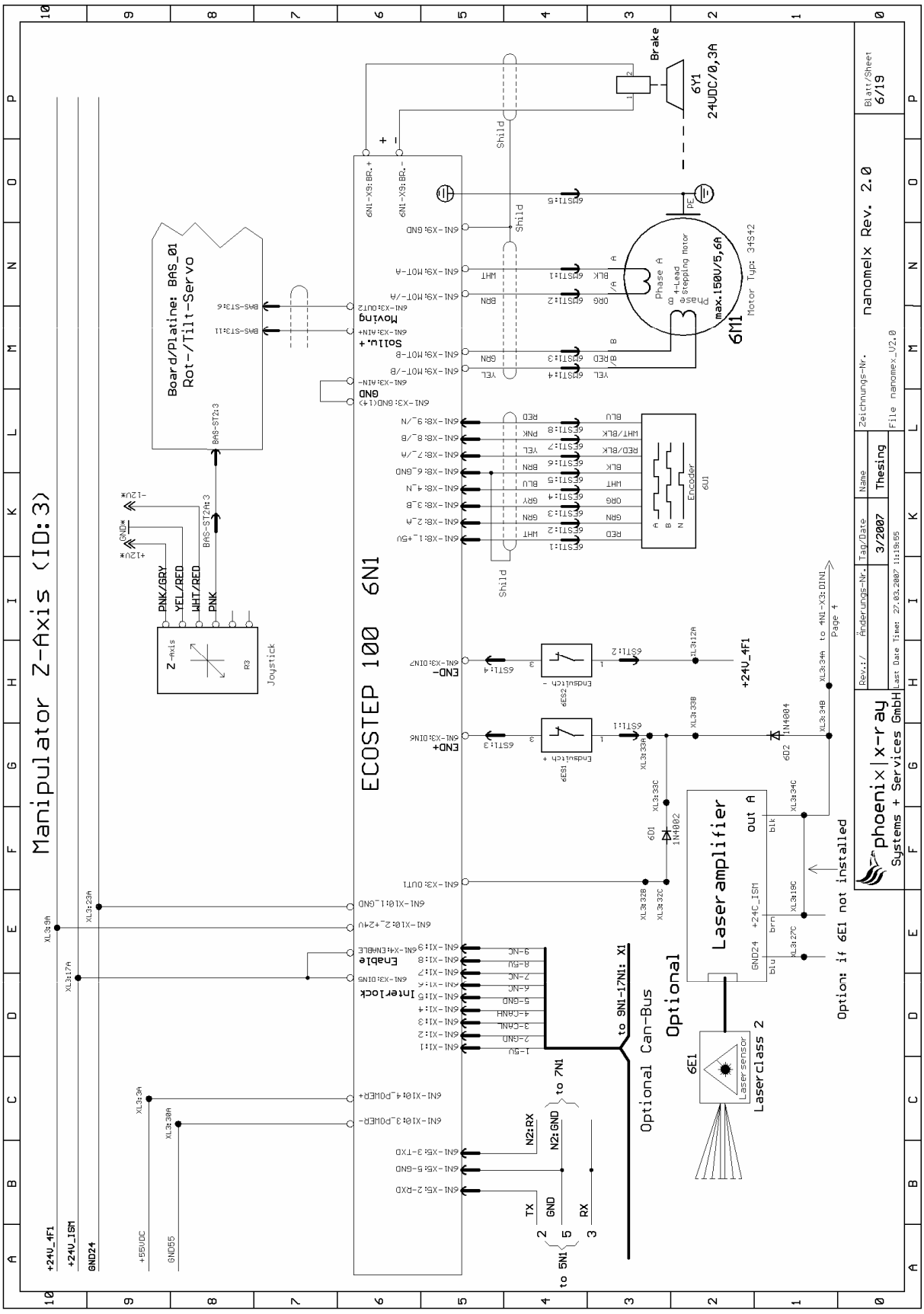
Manipulator Z-Axis (ID:3)
ECOSTEP 100 6N1
Board/Platine: BAS_01
Rot-/Tilt-Servo
Moving
Soll.+
GND
Brake
6Y1
24VDC/0,3A
6M1
max.150W/5,6A
Motor Typ: 34S42
Phase A
Phase B
4-Lead Stepping Motor
Encoder
6U1
Z-Axis
Joystick
PNK/GRY
YEL/RED
WHT/RED
PNK
Interlock
Enable
Optional Can-Bus
to 9N1-17N1: X1
Optional
Laser amplifier
out A
+24C_ISM
GND24
6E1
Laserclass 2
Laser sensor
Option: if 6E1 not installed
+24V_4F1
+24V_ISM
GND24
+5VDC
GNDS5
TX
GND
RX
to 5N1
to 7N1
N2:RX
N2:GND
Shild
phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
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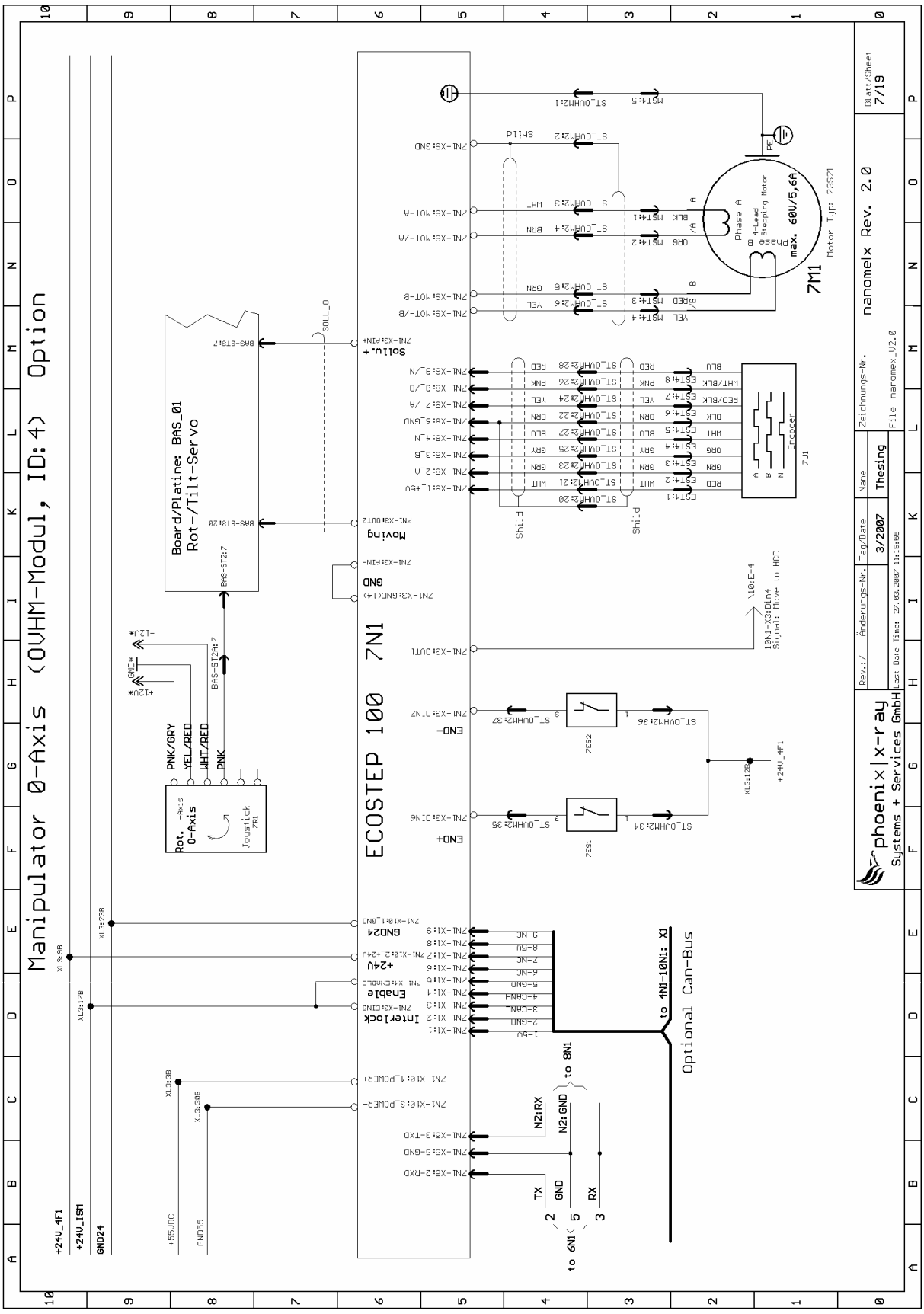
Manipulator 0-Axis (OVHM-Modul, ID:4) Option
ECOSTEP 100 7N1
Board/Platine: BAS_01
Rot-/Tilt-Servo
Joystick
Rot. -Axis
0-Axis
7M1
Motor Typ 23S21
max. 60V/5,6A
4-Lead Stepping Motor
Phase A
Phase B
Encoder
7U1
Interlock
Enable
+24U
GND24
END+
END-
Moving
GND
Solid+
Shild
Optional Can-Bus
to 4N1-10N1: X1
to 8N1
to 6N1
TX
RX
GND
+55VDC
GND55
+24V_4F1
+24V_ISM
GND24
phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
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Tag/Date
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Rev.:
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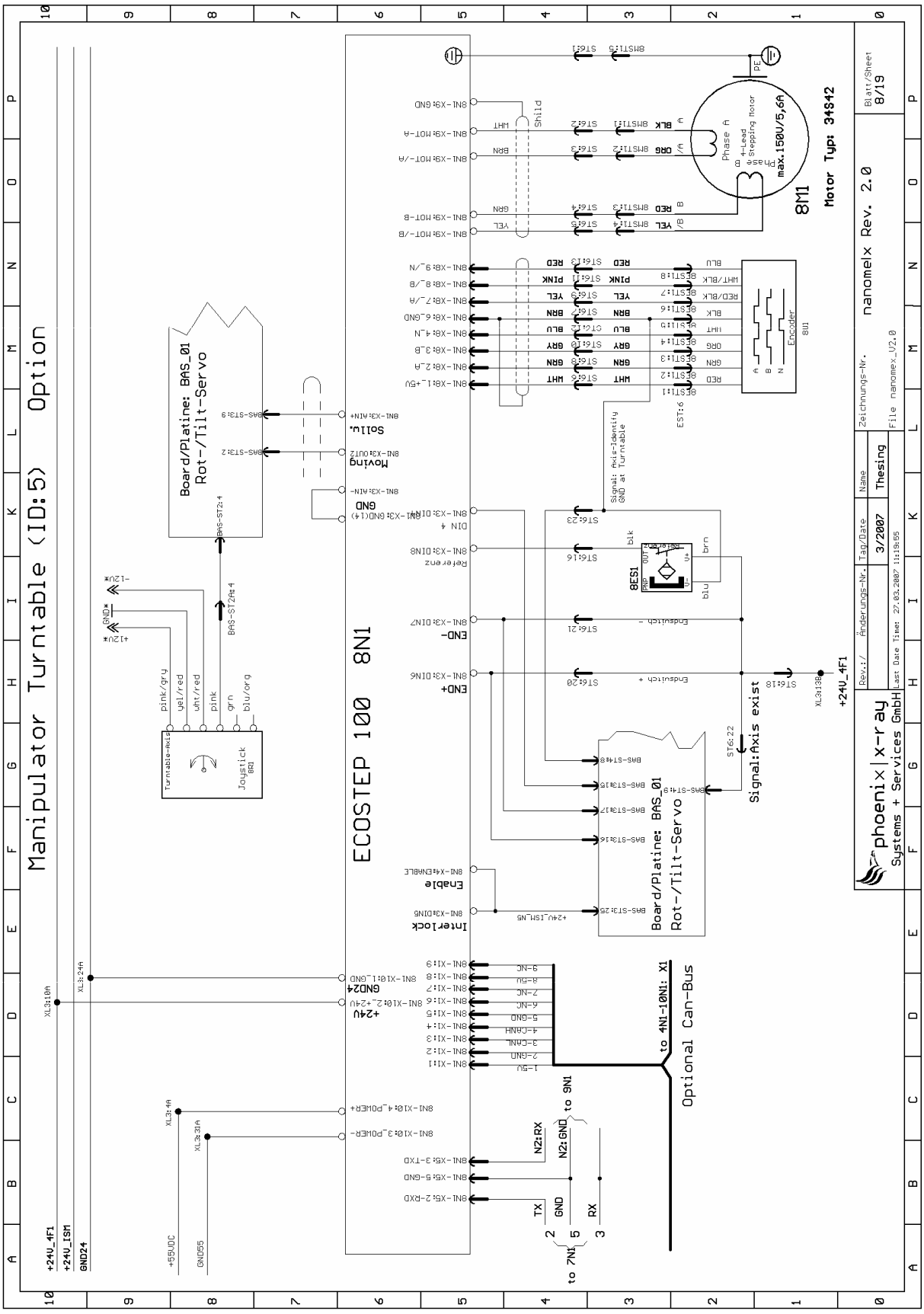
Manipulator Turntable (ID:5) Option
ECOSTEP 100 8N1
Board/Platine: BAS_01
Rot-/Tilt-Servo
Motor Typ: 34342
8M1
Optional Can-Bus
Signal:Axis exist
Interlock
Enable
END+
END-
GND
Moving
Soll u.
Joystick
8R1
Encoder
8U1
8ES1
Endswitch +
Endswitch -
Phase A
Phase B
4-Lead Stepping Motor
max.150U/5,6A
phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
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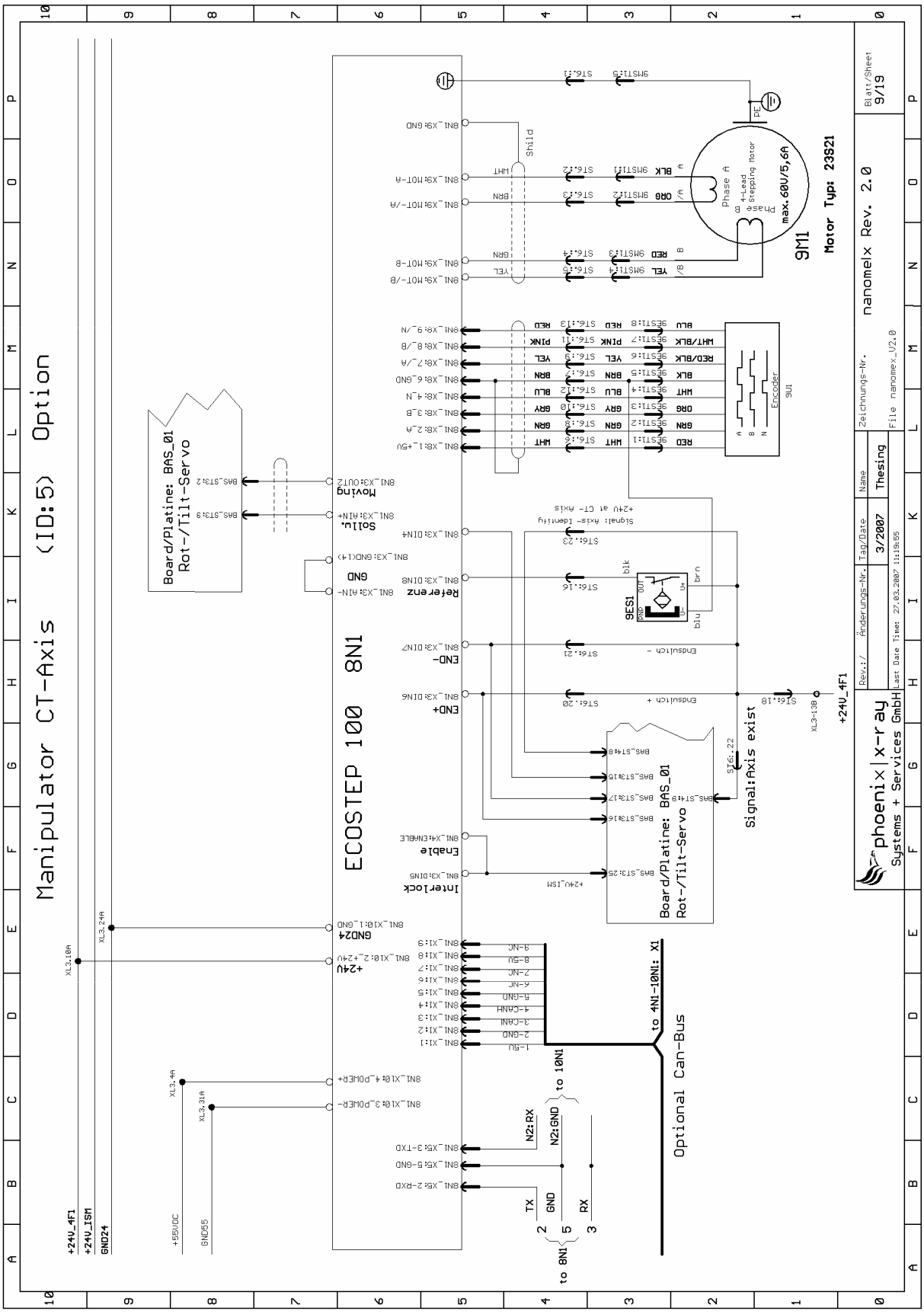
+24U_4F1
+24U_1SM
GND24
+55VDC
GND55
+24U
GND24
to 4N1-10N1: X1
to 9N1
to 7N1


Manipulator CT-Axis (ID:5) Option
ECOSTEP 100 8N1
9M1
Motor Typ: 23S21
max.60V/5,6A
Phase A
4-Lead Stepping Motor
Encoder
9S1
Board/Platine: BAS_01
Rot-/Tilt-Servo
Moving
Soll
GND
Referenz
END-
END+
Enable
Interlock
GND24
+24U
Signal:Axis exist
Endswitch -
Endswitch +
9ES1
Optional Can-Bus
to 4N1-10N1: X1
to 10N1
to 8N1
N2:RX
N2:GND
TX
GND
RX
+24V_4F1
+24V_1SM
GND24
+5VUDC
GND5
Shild
nanome|x Rev. 2.0
Systems + Services GmbH
Thesing
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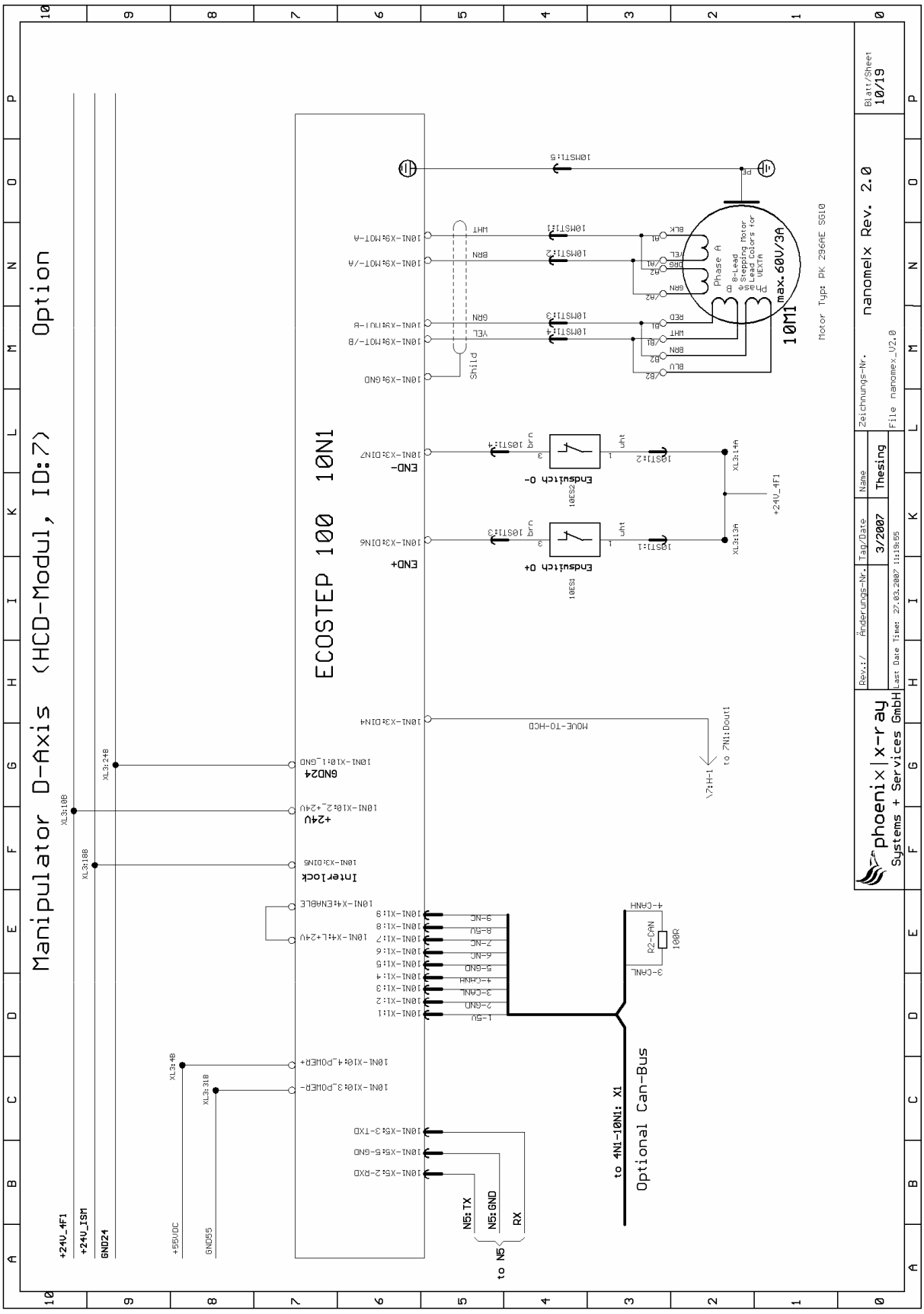
File nanomex_V2.0


Manipulator D-Axis (HCD-Modul, ID:7) Option
ECOSTEP 100 10N1
10M1 max.60V/3A
Motor Typ PK 296AE SG10
Optional Can-Bus
to 4N1-10N1: X1
to N5
N5:TX
N5:GND
RX
+24V_4F1
+24V_ISM
GND24
+5VDC
GND5
Interlock
END+
END-
Endswitch 0+
Endswitch 0-
Phase A
8-Lead Stepping Motor Lead Colors for VEXTA
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Systems + Services GmbH
nanome|x Rev. 2.0
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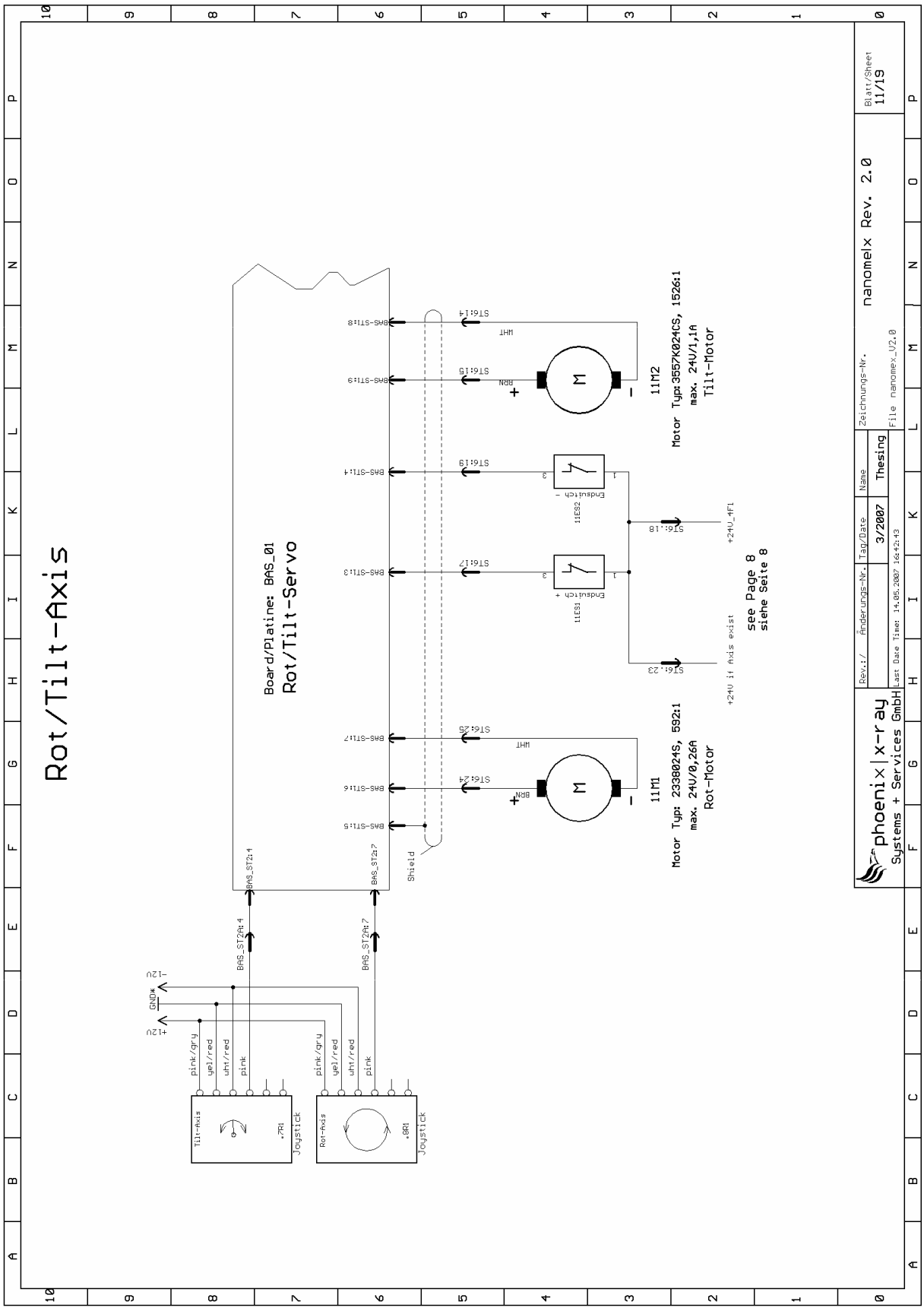
Rot/Tilt-Axis
Board/Platine: BAS_01
Rot/Tilt-Servo
BAS-ST1:8
BAS-ST1:9
BAS-ST1:4
BAS-ST1:3
BAS-ST1:7
BAS-ST1:6
BAS-ST1:5
ST6:14
ST6:15
ST6:19
ST6:17
ST6:25
ST6:24
ST6:18
ST6:23
WHT
BRN
11M2
Motor Typ:3557K024CS, 152:1
max. 24V/1,1A
Tilt-Motor
11M1
Motor Typ: 2338024S, 592:1
max. 24V/0,26A
Rot-Motor
11ES2
11ES1
Endschalter
+24V_4Fl
+24V if axis exist
see Page 8
siehe Seite 8
Shield
BAS_ST2:4
BAS_ST2:7
-12V
GND
+12V
pink/gry
yel/red
wht/red
pink
Tilt-Axis
.7R1
Joystick
Rot-Axis
.6R1
phoenix|x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
Zeichnungs-Nr.
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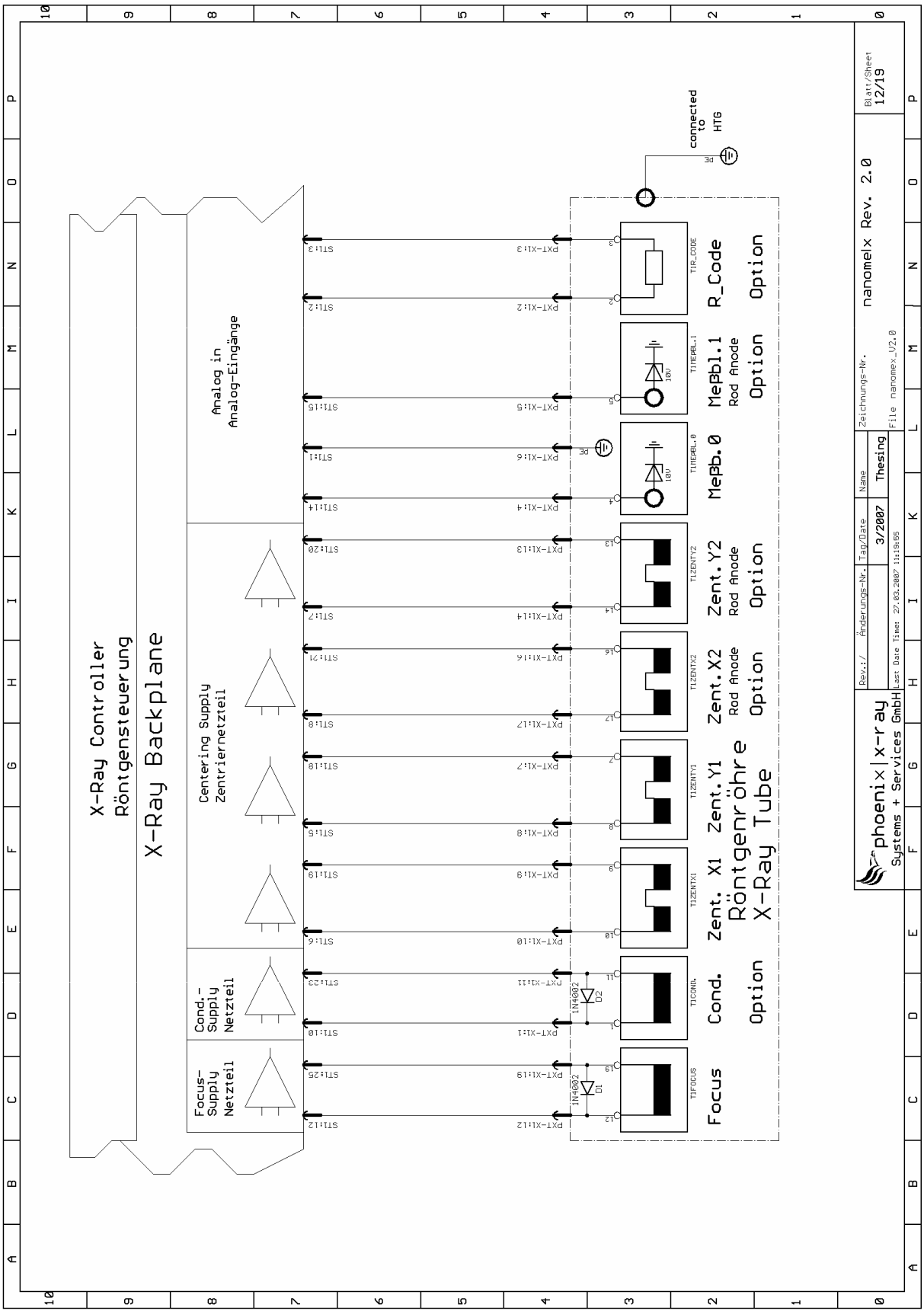
X-Ray Controller
Röntgensteuerung
X-Ray Backplane
Analog in
Analog-Eingänge
Centering Supply
Zentriernetzteil
Cond.-
Supply
Netzteil
Focus-
Supply
Netzteil
connected
to
HTG
PE
Focus
Cond.
Zent. X1
Zent.Y1
Zent.X2
Zent.Y2
MeBb.0
MeBbl.1
R_Code
Option
Röntgenröhre
X-Ray Tube
Rod Anode
1N4002
D1
D2
10V
nanome|x Rev. 2.0
phoenix|x-ray
Systems + Services GmbH
Name
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Tag/Date
3/2007
Zeichnungs-Nr.
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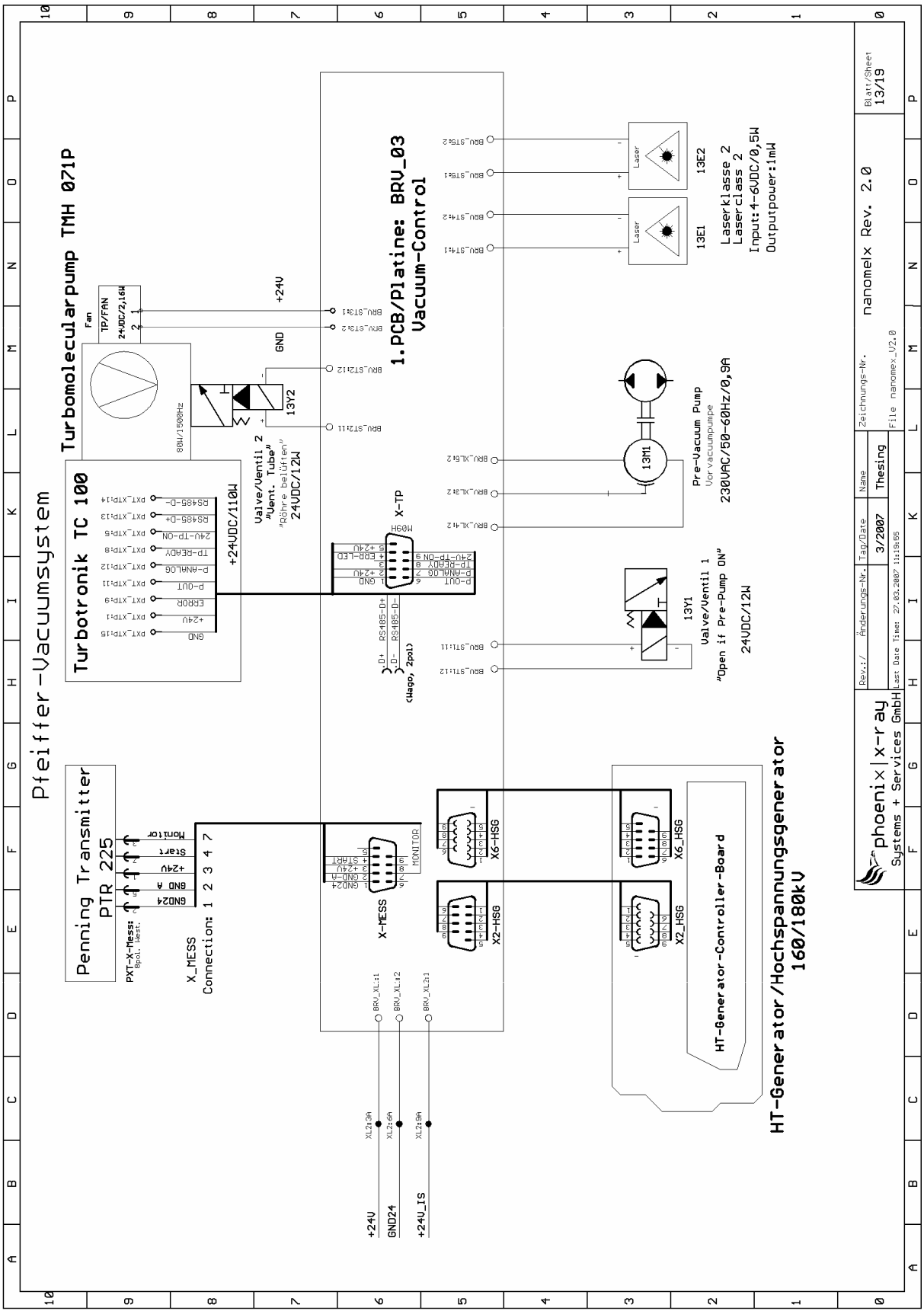
Pfeiffer-Vacuumsystem
Turbomolecularpump TMH 071P
Turbotronik TC 100
Fan
TP/FAN
24VDC/2,16A
80W/1500Hz
Valve/Ventil 2
"Vent. Tube"
"Röhre belüften"
24VDC/12W
+24VDC/110W
13Y2
+24V
GND
1.PCB/Platine: BRV_03
Vacuum-Control
X-TP
H60W
13E1
13E2
Laserklasse 2
Laserclass 2
Input:4-6VDC/0,5W
Outputpower:1mW
13M1
Pre-Vacuum Pump
Vorvacuumpumpe
230VAC/50-60Hz/0,9A
13Y1
Valve/Ventil 1
"Open if Pre-Pump ON"
24VDC/12W
Penning Transmitter
PTR 225
PKT-X-Mess:
X_MESS
Connection: 1 2 3 4 7
X-MESS
MONITOR
X6-HSG
X2-HSG
HT-Generator-Controller-Board
HT-Generator/Hochspannungsgenerator
160/180kV
+24V
GND24
+24V_IS
phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
Zeichnungs-Nr.
File nanomex_V2.0
Name
Thesing
Tag/Date
3/2007
Änderungs-Nr.
Rev.:/
Last Date Time: 27.03.2007 11:19:55
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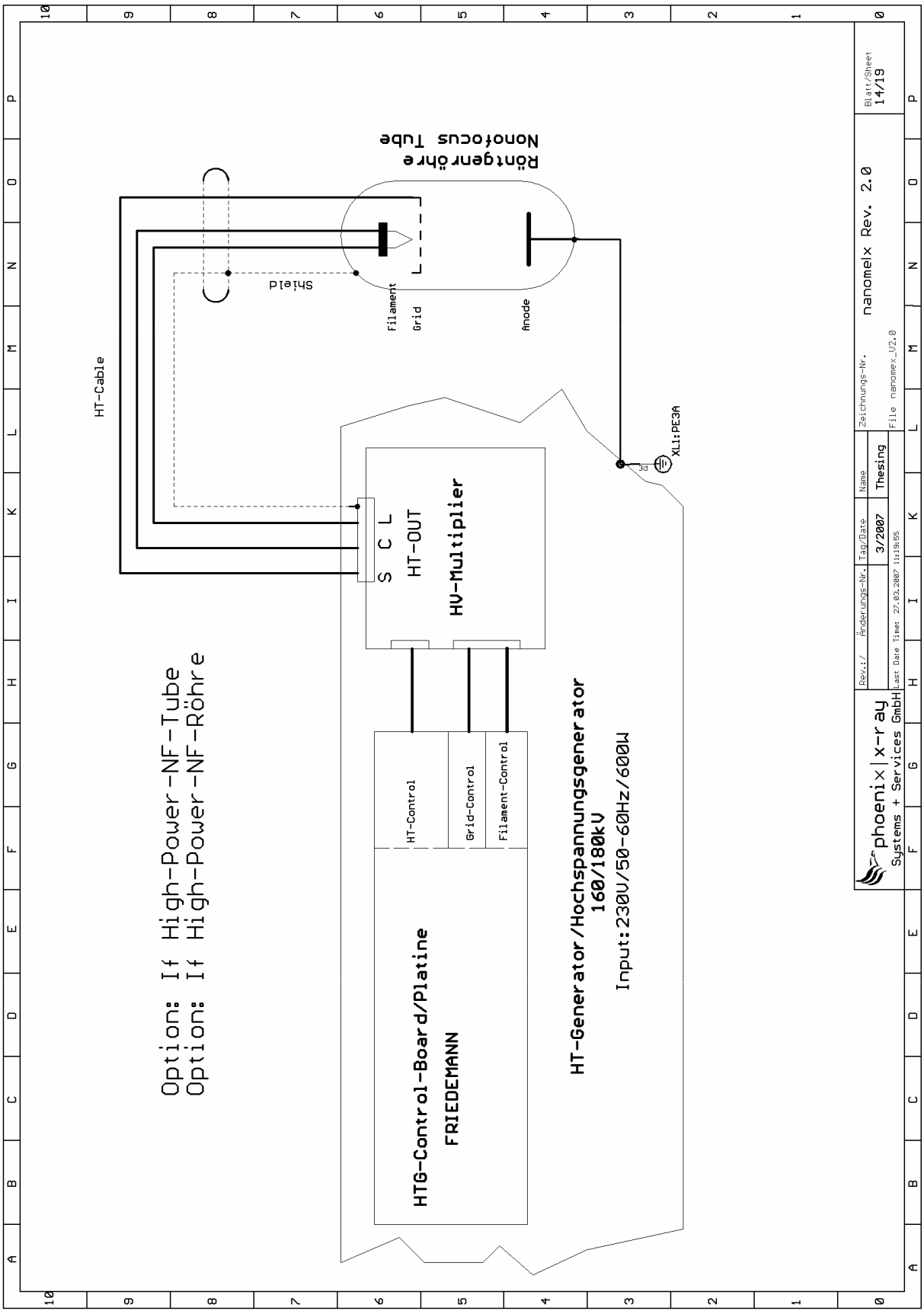
Röntgenröhre
Nanofocus Tube
Shield
Filament
Grid
Anode
HT-Cable
XL1:PE3A
PE
S C L
HT-OUT
HV-Multiplier
HT-Control
Grid-Control
Filament-Control
HTG-Control-Board/Platine
FRIEDEMANN
HT-Generator/Hochspannungsgenerator
160/180kV
Input:230V/50-60Hz/600W
Option: If High-Power-NF-Tube
Option: If High-Power-NF-Röhre
phoenix|x-ray
Systems + Services GmbH
Rev.:/ Änderungs-Nr.
Tag/Date 3/2007
Name Thesing
Zeichnungs-Nr. nanome|x Rev. 2.0
File nanomex_V2.0
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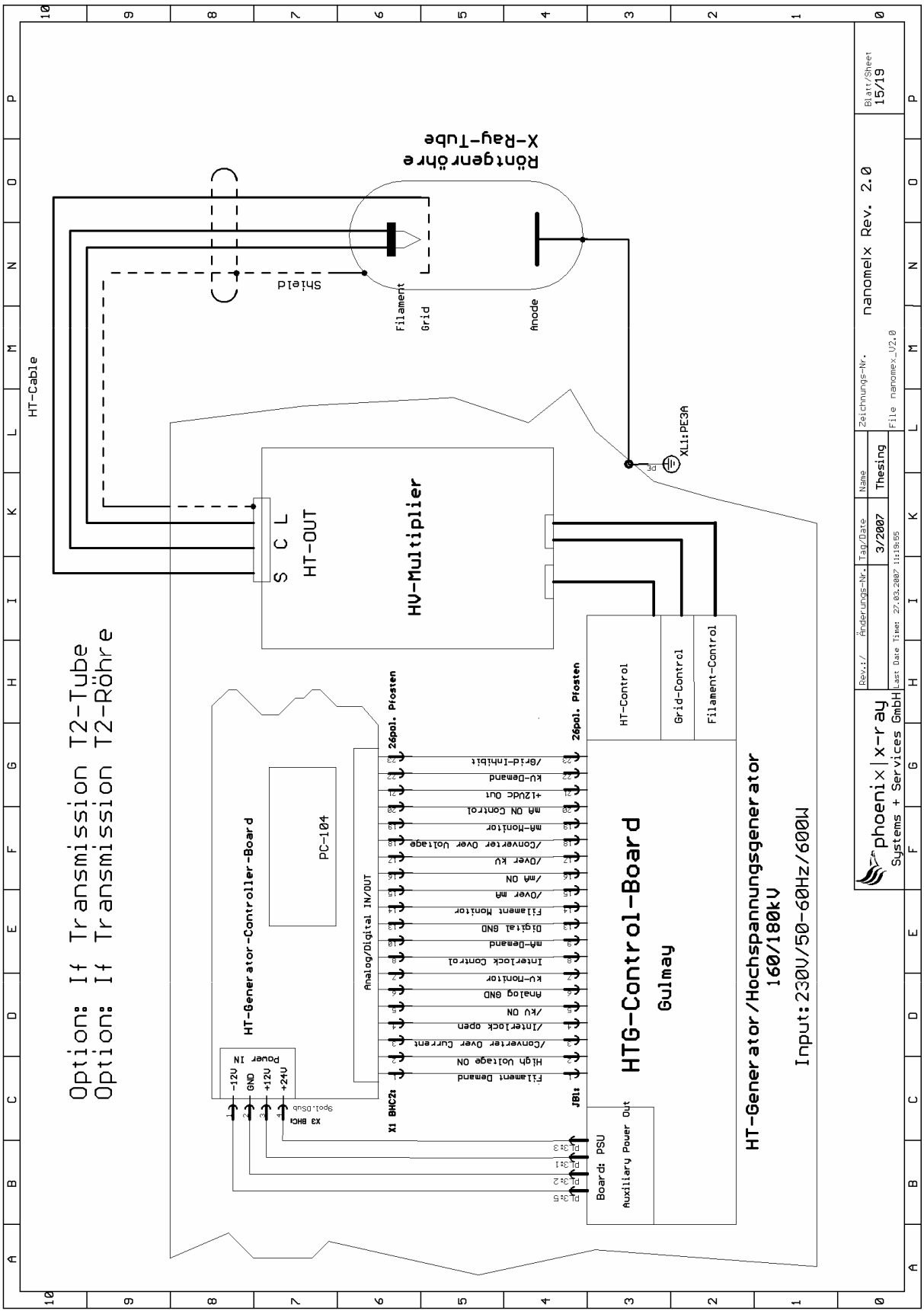
Röntgenröhre
X-Ray-Tube
Shield
Filament
Grid
Anode
HT-Cable
HV-Multiplier
HT-OUT
S C L
XL1:PE3A
PE
Option: If Transmission T2-Tube
Option: If Transmission T2-Röhre
HT-Generator-Controller-Board
PC-104
Analog/Digital IN/OUT
26pol. Prosten
X1 BHC2:
JB1:
Power IN
-12V
GND
+12V
+24V
X3 BHC1
9pol.DSub
/Grid-Inhibit
kV-Demand
+12Vdc Out
mA ON Control
mA-Monitor
/Converter Over Voltage
/Over kV
/mA ON
/Over mA
Filament Monitor
Digital GND
mA-Demand
Interlock Control
kV-Monitor
Analog GND
/kV ON
/Interlock open
/Converter Over Current
High Voltage ON
Filament Demand
HTG-Control-Board
Gulmay
Board: PSU
Auxiliary Power Out
HT-Control
Grid-Control
Filament-Control
HT-Generator/Hochspannungsgenerator
160/180kV
Input:230V/50-60Hz/600W
phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0
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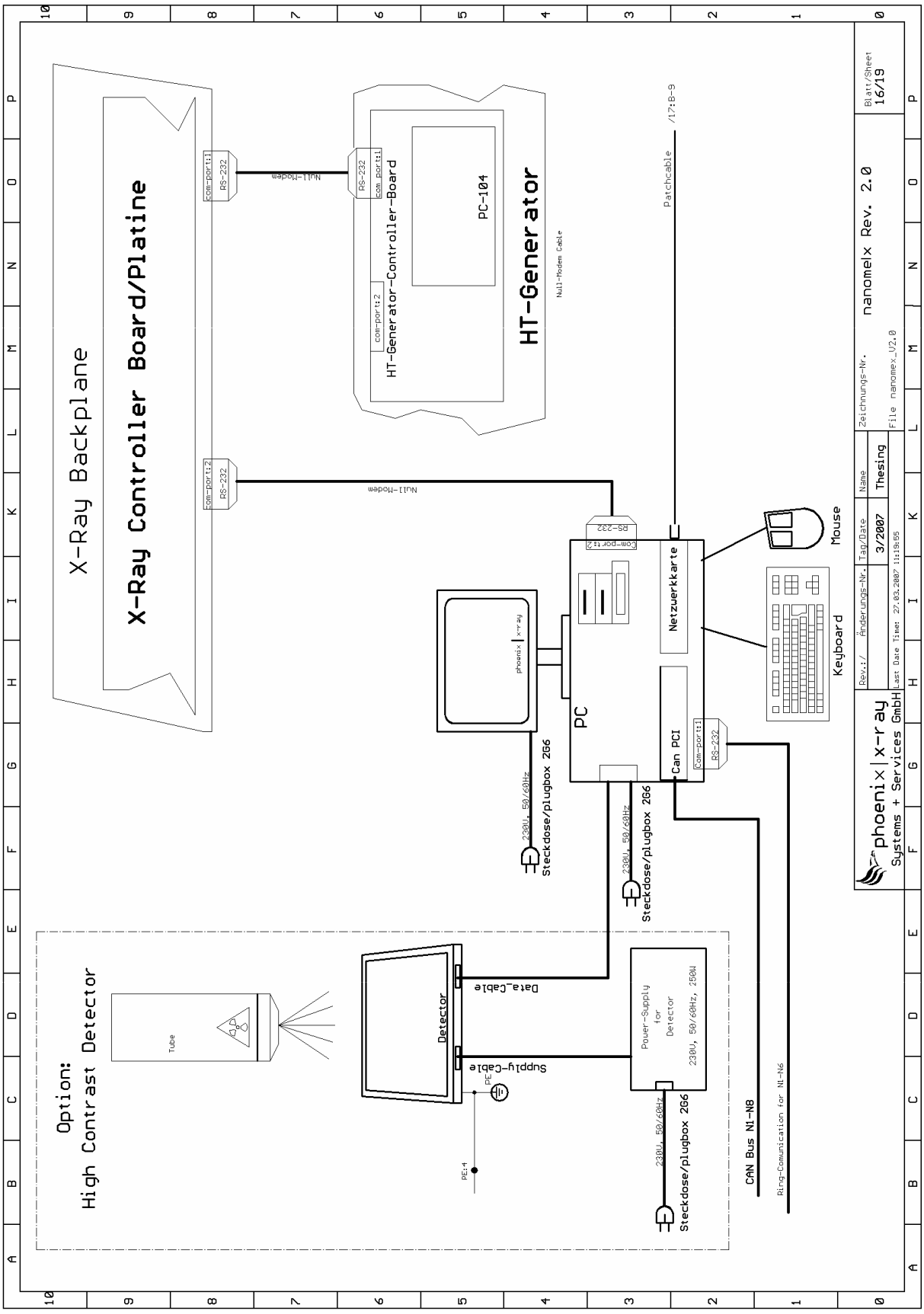
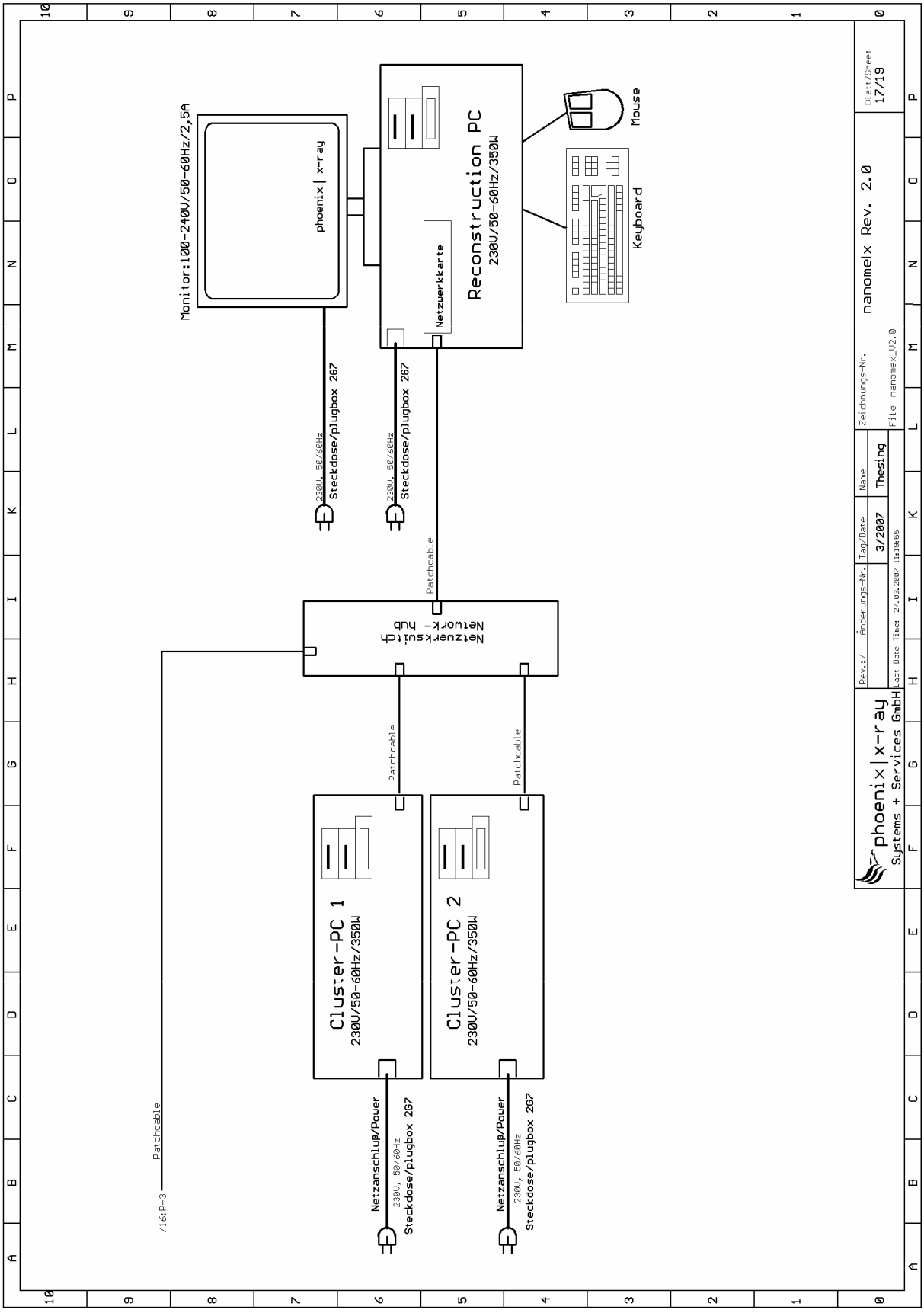
Zeichnungs-Nr.
File nanomex_V2.0
Name
Thesing
Tag/Date
3/2007
Änderungs-Nr.
Rev.:/
Last Date Time: 27.03.2007 11:19:55


X-Ray Backplane
X-Ray Controller Board/Platine
HT-Generator
HT-Generator-Controller-Board
PC-104
Null-Modem Cable
Patchcable
PC
Netzwerkkarte
Can PCI
Keyboard
Mouse
Steckdose/plugbox 266
Option:
High Contrast Detector
Tube
Detector
Data_Cable
Supply-Cable
Power-Supply for Detector
CAN Bus N1-N8
Ring-Comunication for N1-N6
phoenix | x-ray
Systems + Services GmbH
nanome|x Rev. 2.0


Monitor:100-240V/50-60Hz/2,5A
phoenix| x-ray
Reconstruction PC
230V/50-60Hz/350W
Netzwerkkarte
Mouse
Keyboard
230V, 50/60Hz
Steckdose/plugbox 267
230V, 50/60Hz
Steckdose/plugbox 267
Patchcable
Netzwerk switch
Network - hub
Patchcable
Patchcable
Patchcable
Cluster-PC 1
230V/50-60Hz/350W
Cluster-PC 2
230V/50-60Hz/350W
/16P-3
Netzanschluß/Power
230V, 50/60Hz
Steckdose/plugbox 267
Netzanschluß/Power
230V, 50/60Hz
Steckdose/plugbox 267
phoenix| x-ray
Systems + Services GmbH
Rev.:/ Änderungs-Nr.
Tag/Date
3/2007
Name
Thesing
Last Date Time: 27.03.2007 11:19:55
Zeichnungs-Nr.
nanome|x Rev. 2.0
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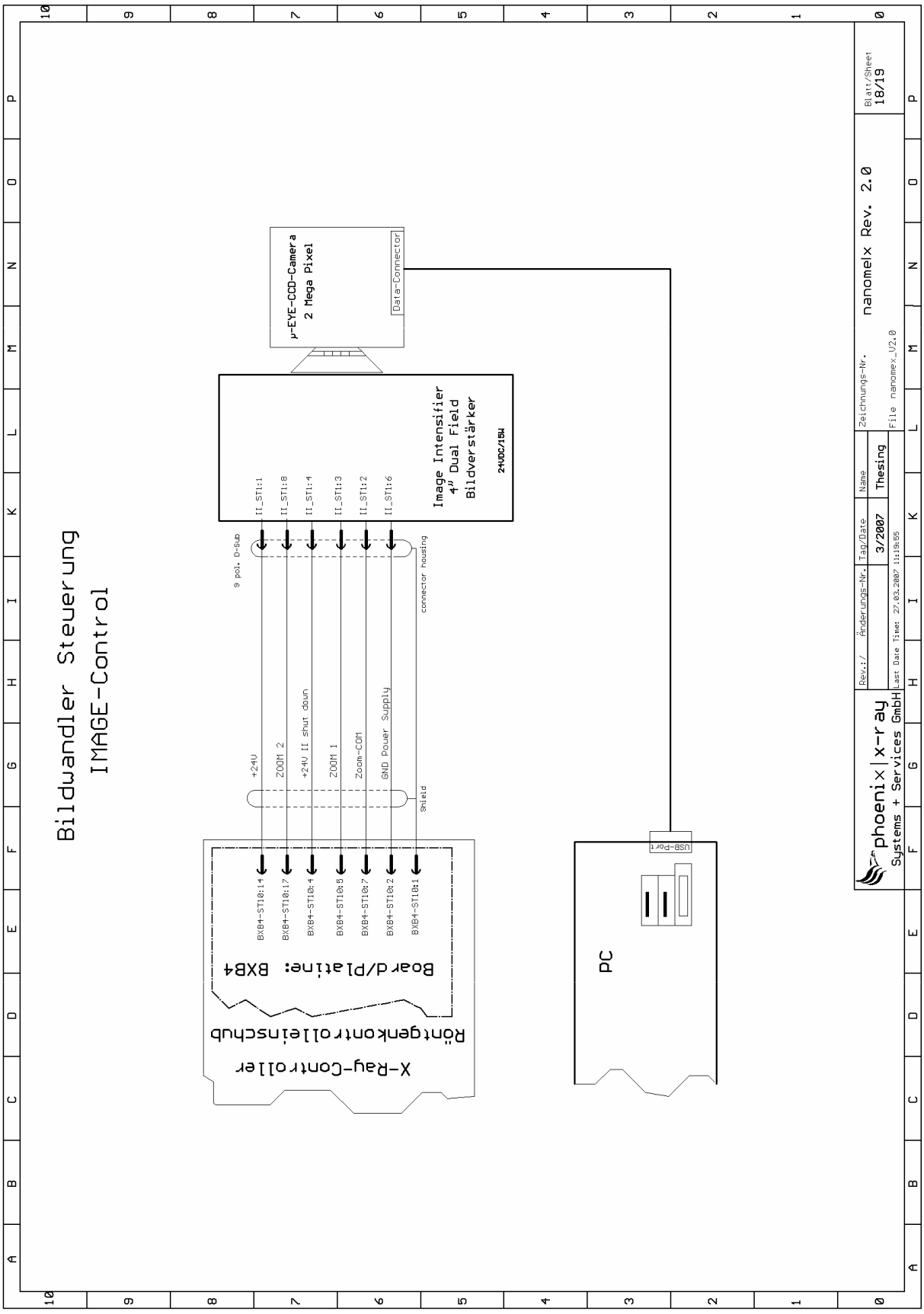
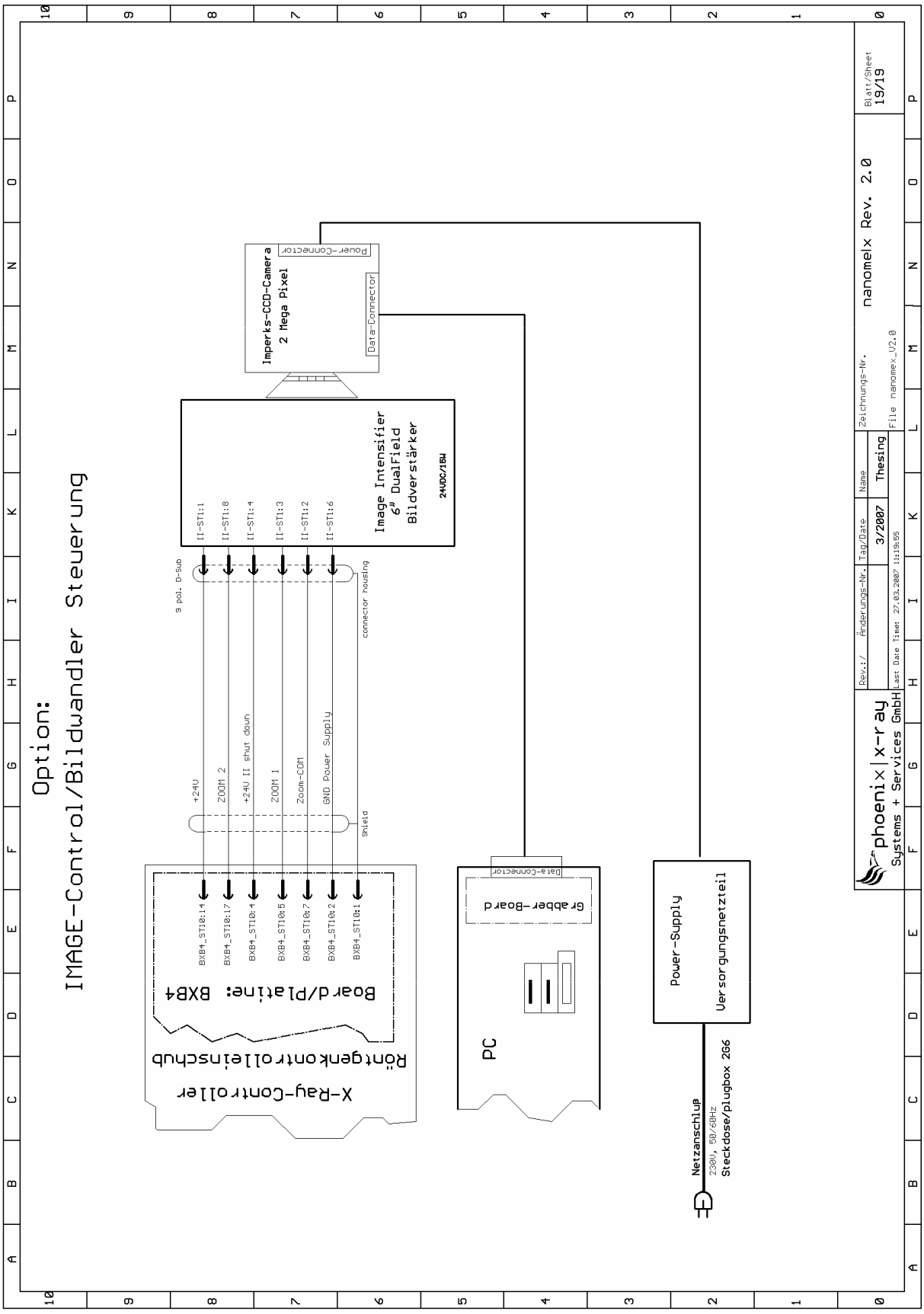
17/19


Bildwandler Steuerung
IMAGE-Control
µ-EYE-CCD-Camera
2 Mega Pixel
Data-Connector
Image Intensifier
4" Dual Field
Bildverstärker
24VDC/15W
II_ST1:1
II_ST1:8
II_ST1:4
II_ST1:3
II_ST1:2
II_ST1:6
9 pol. D-Sub
connector housing
+24U
ZOOM 2
+24U II shut down
ZOOM 1
Zoom-COM
GND Power Supply
Shield
BXB4-ST10:14
BXB4-ST10:17
BXB4-ST10:4
BXB4-ST10:5
BXB4-ST10:7
BXB4-ST10:2
BXB4-ST10:1
Board/Platine: BXB4
Röntgenkontrolleinschub
X-Ray-Controller
PC
USB-Port
phoenix| x-ray
Systems + Services GmbH
Rev.:/ Änderungs-Nr.
Tag/Date 3/2007
Name Thesing
Last Date Time: 27.03.2007 11:19:55
Zeichnungs-Nr.
nanome|x Rev. 2.0
File nanomex_V2.0
Blatt/Sheet 18/19


Option:
IMAGE-Control/Bildwandler Steuerung
Imperks-CCD-Camera
2 Mega Pixel
Power-Connector
Data-Connector
Image Intensifier
6" DualField
Bildverstärker
24VDC/15W
II-STI:1
II-STI:8
II-STI:4
II-STI:3
II-STI:2
II-STI:6
9 pol. D-Sub
connector housing
+24U
ZOOM 2
+24U II shut down
ZOOM 1
Zoom-COM
GND Power Supply
Shield
BXB4_ST10:14
BXB4_ST10:17
BXB4_ST10:4
BXB4_ST10:5
BXB4_ST10:7
BXB4_ST10:2
BXB4_ST10:1
Board/Platine: BXB4
Röntgenkontrolleinschub
X-Ray-Controller
Data-Connector
Grabber-Board
PC
Power-Supply
Versorgungsnetzteil
Netzanschluß
230V, 50/60Hz
Steckdose/plugbox 266
phoenix| x-ray
Systems + Services GmbH
Rev.:/ Änderungs-Nr. Tag/Date Name
3/2007 Thesing
Last Date Time: 27.03.2007 11:19:55
Zeichnungs-Nr. nanome|x Rev. 2.0
File nanomex_V2.0
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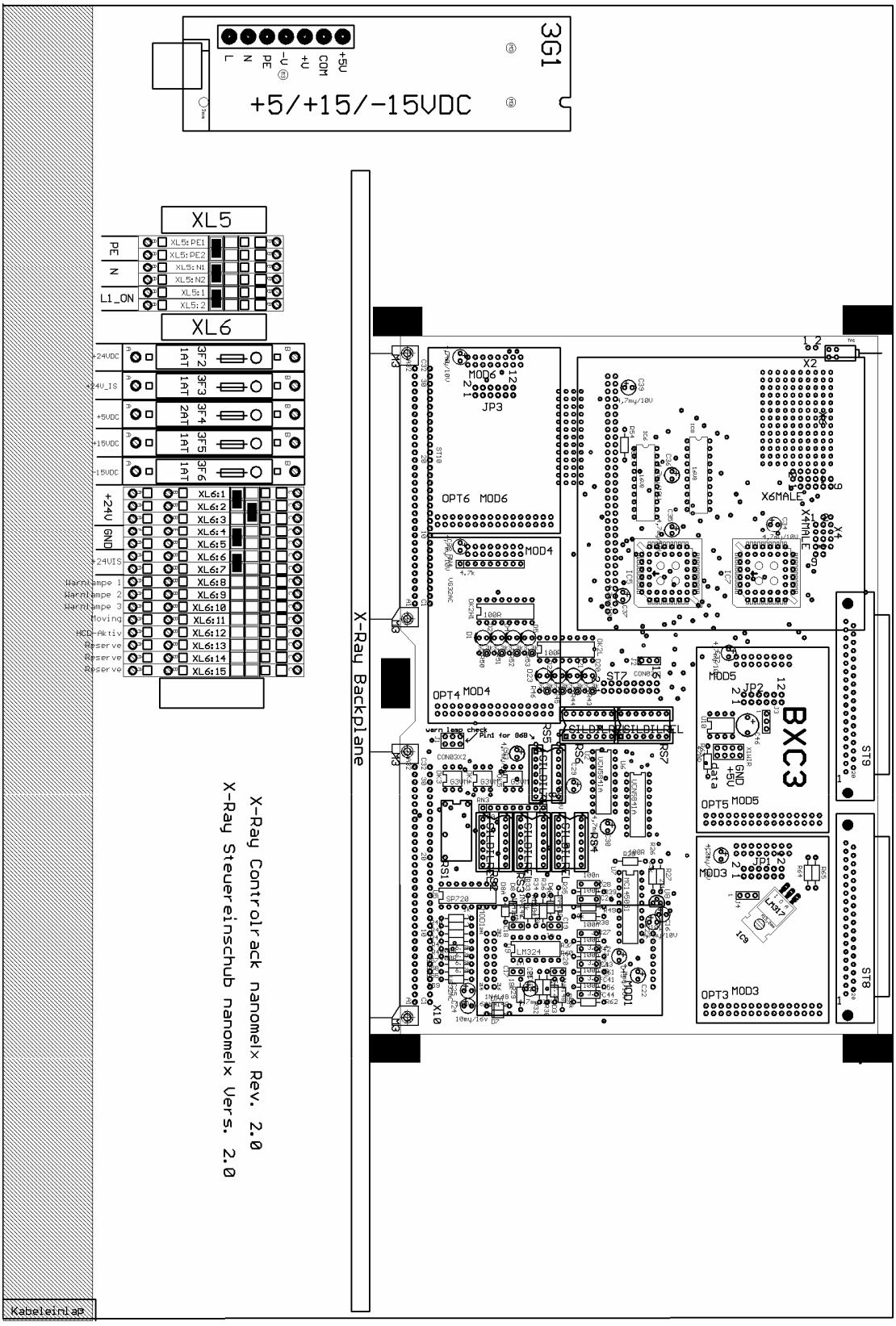
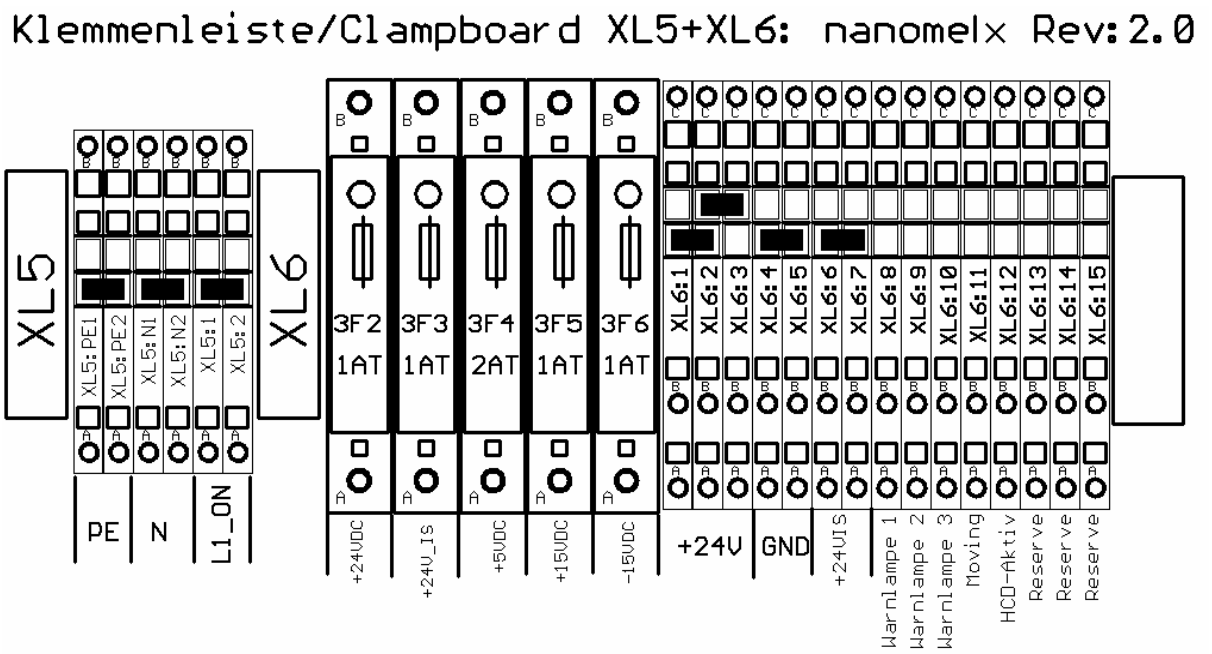
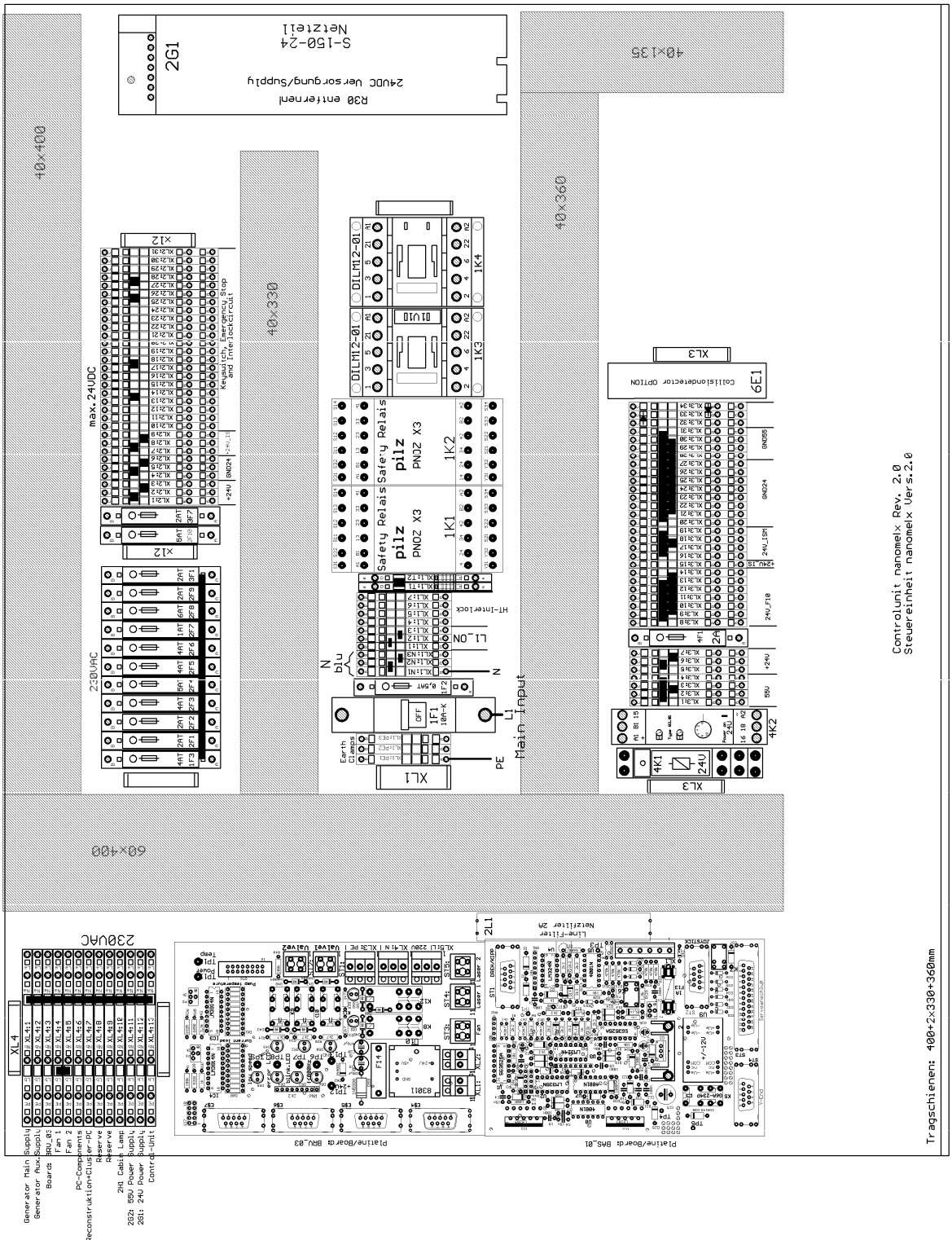
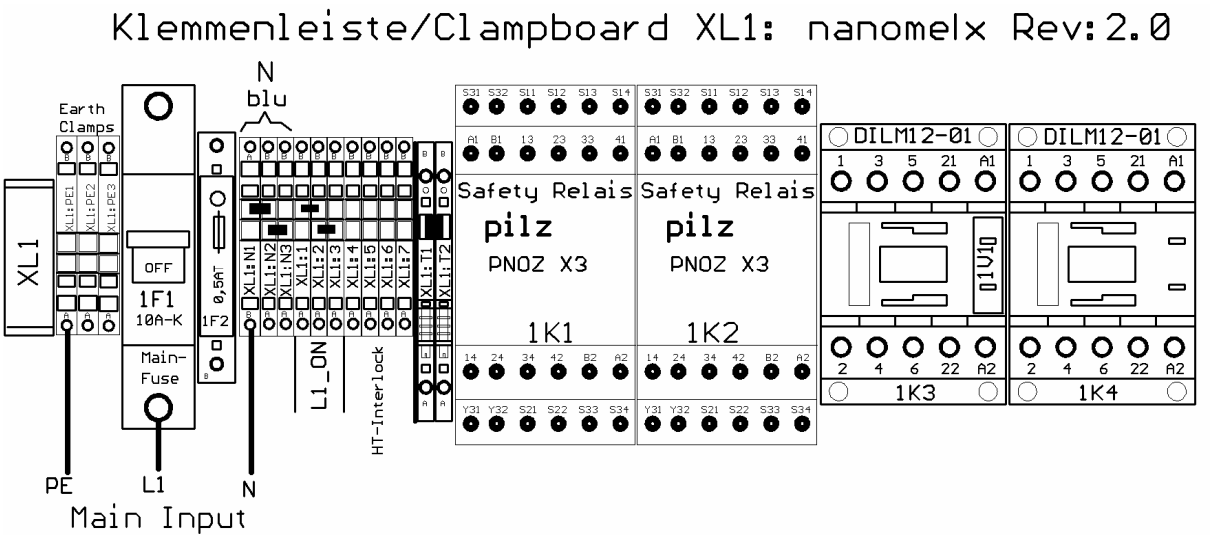
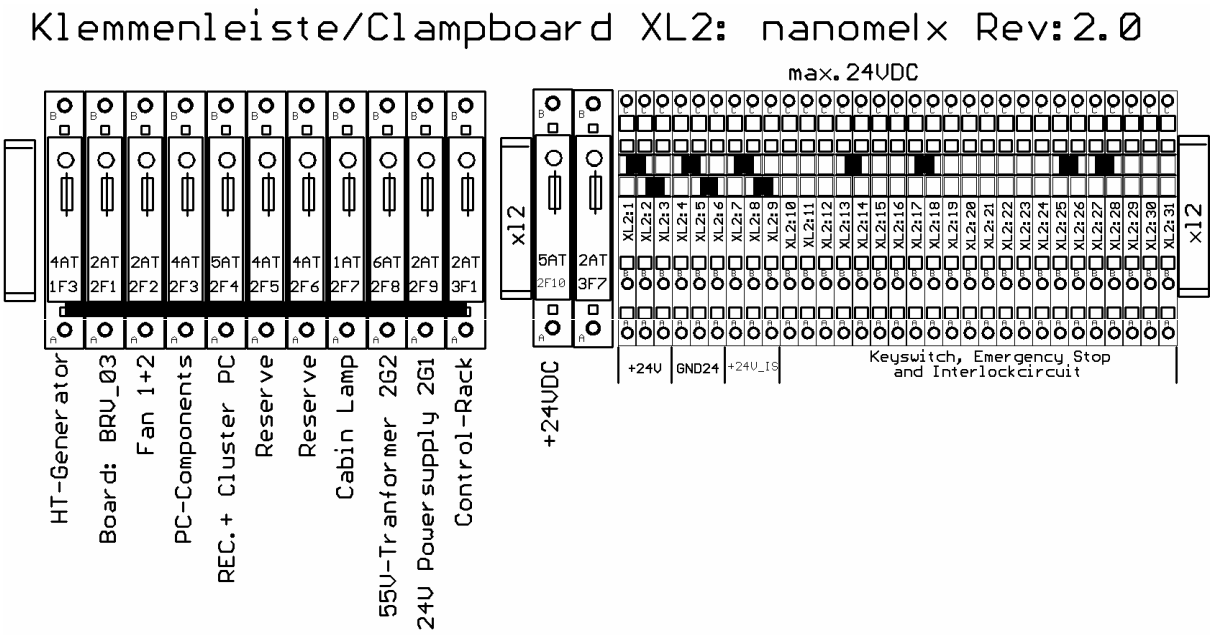
17.3 Clamp boards

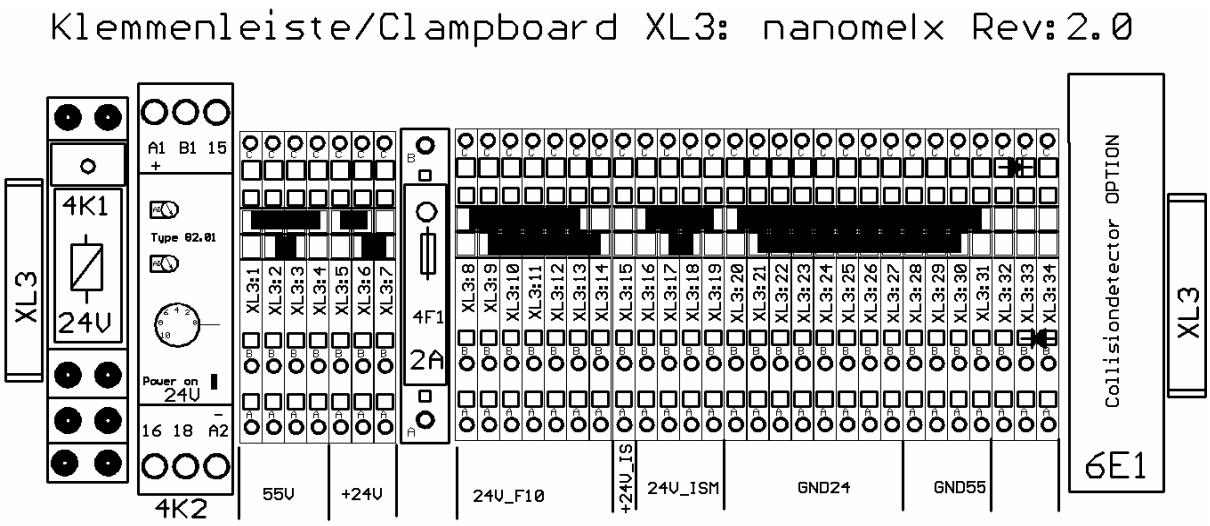


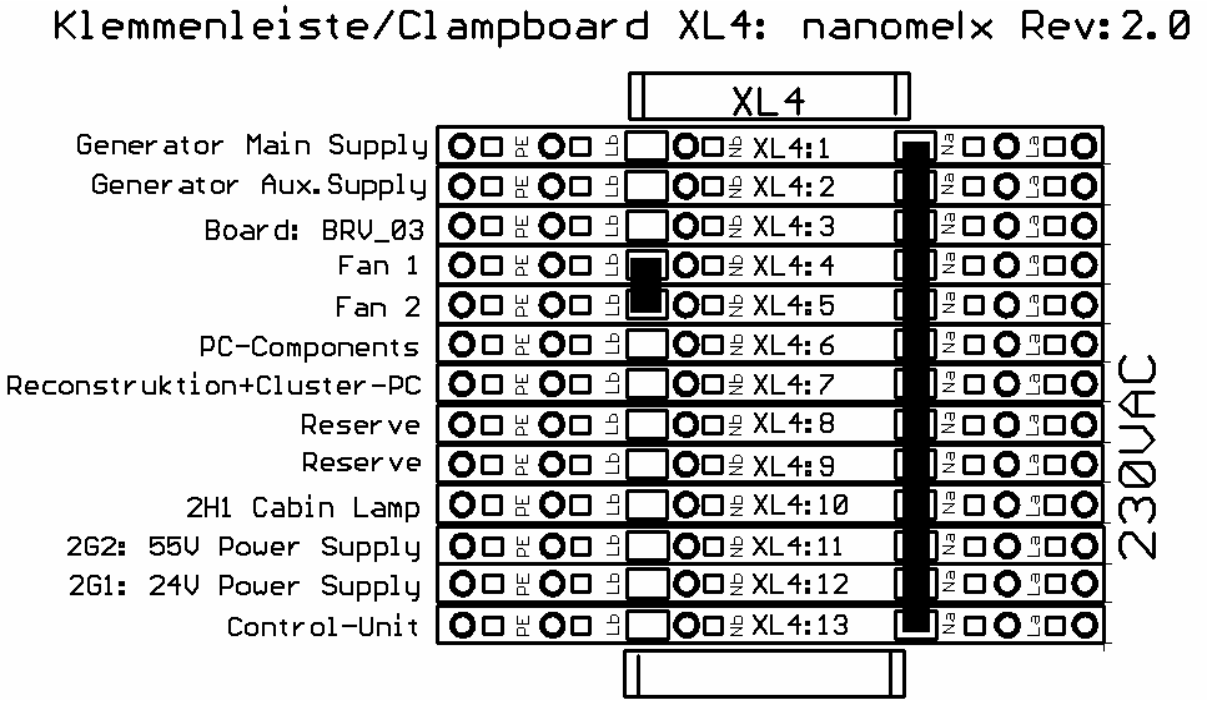

Klemmenleiste/Clampboard XL5+XL6: nanomelx Rev:2.0
XL5
XL6
XL5:PE1
XL5:PE2
XL5:N1
XL5:N2
XL5:1
XL5:2
PE
N
L1_ON
3F2 1AT
3F3 1AT
3F4 2AT
3F5 1AT
3F6 1AT
+24VDC
+24V_IS
+5VDC
+15VDC
-15VDC
XL6:1
XL6:2
XL6:3
XL6:4
XL6:5
XL6:6
XL6:7
XL6:8
XL6:9
XL6:10
XL6:11
XL6:12
XL6:13
XL6:14
XL6:15
+24V
GND
+24VIS
Warnlampe 1
Warnlampe 2
Warnlampe 3
Moving
HCD-Aktiv
Reserve
Reserve
Reserve

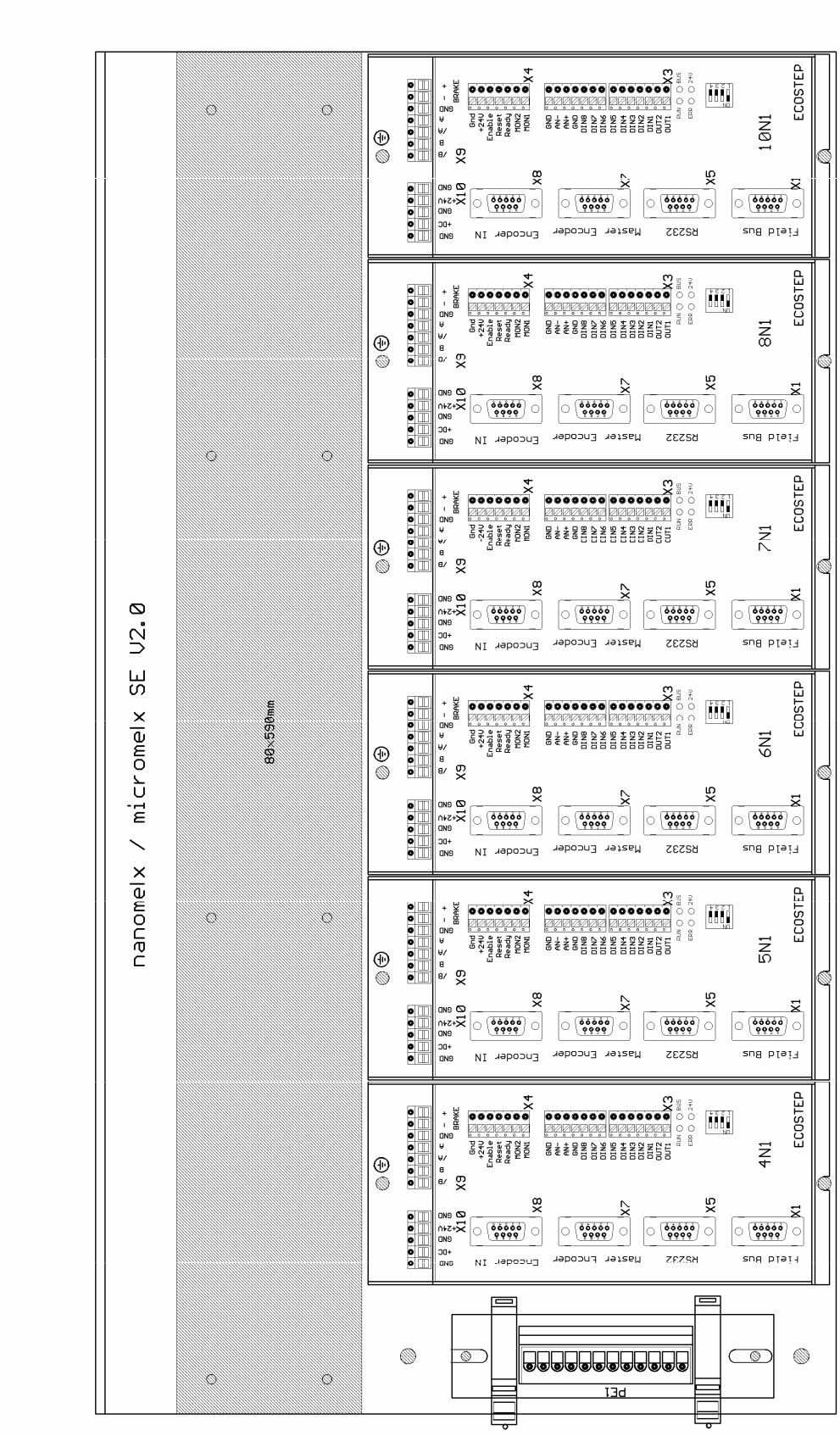

Controlunit nanome|x Rev. 2.0
Steuereinheit nanome|x Vers.2.0
Tragschiene: 400+2×330+360mm
Plaine/Board BAS_01
Plaine/Board BRU_03
Line-Filter
Netzfilter 2A
Main Input
Safety Relais
pilz
PNOZ X3
Collisiondetector OPTION
Keyswitch, Emergency Stop and Interlockcircuit
max. 24VDC
230VAC
24VDC Versorgung/Supply
R30 entfernen
S-150-24
Netzteil
2G1
XL1
XL2
XL3
XL4
1K1
1K2
1K3
1K4
1F1
4K1
4K2
1E9
40×135
40×360
40×330
40×400
60×400


Klemmenleiste/Clampboard XL1: nanomelx Rev:2.0
Earth Clamps
XL1
OFF
1F1
10A-K
Main-Fuse
0,5AT
1F2
N
blu
L1_ON
HT-Interlock
Safety Relais
pilz
PNOZ X3
1K1
1K2
DILM12-01
1K3
1K4
PE
L1
N
Main Input


Klemmenleiste/Clampboard XL2: nanomelx Rev:2.0
max.24VDC
x12
4AT 1F3
2AT 2F1
2AT 2F2
4AT 2F3
5AT 2F4
4AT 2F5
4AT 2F6
1AT 2F7
6AT 2F8
2AT 2F9
2AT 3F1
5AT 2F10
2AT 3F7
XL2:1
XL2:2
XL2:3
XL2:4
XL2:5
XL2:6
XL2:7
XL2:8
XL2:9
XL2:10
XL2:11
XL2:12
XL2:13
XL2:14
XL2:15
XL2:16
XL2:17
XL2:18
XL2:19
XL2:20
XL2:21
XL2:22
XL2:23
XL2:24
XL2:25
XL2:26
XL2:27
XL2:28
XL2:29
XL2:30
XL2:31
HT-Generator
Board: BRV_03
Fan 1+2
PC-Components
REC.+ Cluster PC
Reserve
Reserve
Cabin Lamp
55V-Tranformer 2G2
24V Powersupply 2G1
Control-Rack
+24VDC
+24V
GND24
+24V_IS
Keyswitch, Emergency Stop
and Interlockcircuit


Klemmenleiste/Clampboard XL3: nanomelx Rev:2.0
XL3
4K1
24V
A1 B1 15
+
Type 02.01
Power on
24V
16 18 A2
4K2
XL3:1
XL3:2
XL3:3
XL3:4
XL3:5
XL3:6
XL3:7
4F1
2A
XL3:8
XL3:9
XL3:10
XL3:11
XL3:12
XL3:13
XL3:14
XL3:15
XL3:16
XL3:17
XL3:18
XL3:19
XL3:20
XL3:21
XL3:22
XL3:23
XL3:24
XL3:25
XL3:26
XL3:27
XL3:28
XL3:29
XL3:30
XL3:31
XL3:32
XL3:33
XL3:34
55V
+24V
24V_F10
+24V_IS
24V_ISM
GND24
GND55
Collisiondetector OPTION
6E1
XL3


Klemmenleiste/Clampboard XL4: nanomelx Rev:2.0
XL4
Generator Main Supply
Generator Aux.Supply
Board: BRV_03
Fan 1
Fan 2
PC-Components
Reconstruktion+Cluster-PC
Reserve
Reserve
2H1 Cabin Lamp
2G2: 55V Power Supply
2G1: 24V Power Supply
Control-Unit
PE
Lb
Nb
XL4:1
XL4:2
XL4:3
XL4:4
XL4:5
XL4:6
XL4:7
XL4:8
XL4:9
XL4:10
XL4:11
XL4:12
XL4:13
Na
La
230VAC


nanomelx / micromelx SE V2.0
80/590mm
10N1
8N1
7N1
6N1
5N1
4N1
ECOSTEP
Field Bus
RS232
Master Encoder
Encoder IN
PE1